THE

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THE

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DEGREES IN ENGINEERING.

NEXT Tuesday is set down for the second reading of the London University Commission Bill. This is a matter to be looked to most earnestly by all who desire the welfare and progress of engineering education in London. Young men who are studying the scientific part of engineering in London, are, and have for many years been, at a serious disadvantage as compared with their fellows who may be studying in other centres of the British Islands, since by the antiquated red-tapism that has dominated the Burlington House establishment, they are cut off from the chance of taking a degree in engineering. Young engineers studying in Glasgow, Manchester, Liverpool, Belfast, Cork, Dublin, Leeds, Dundee, or even in Cambridge, find a University degree open to them as the culminating point of their theoretical studies. The student who goes to University College, London, to work in the Engineering Laboratory created by Prof. Kennedy, or to the Central College of the City Guilds' Institute, to say nothing of the engineering courses at King's College, or at any of the newer Technical Institutes, finds no such chance open to him. The institution some 10 years ago of the Engineering Tripos at Cambridge has in reality been a severe blow to the London schools of engineering, cut off as they are from all organic connection with the doctrinaire examining board which possesses the title of University of London.

The Senate of the University seems to think the holding of a schoolboy matriculation in Jamaica of more importance than the creation of an engineering tripos for London students in London. It is, in fact, a London University only in name, being, like the Civil Service Commission, only an examining body, debarred by its very charter from teaching, or from appointing professors, or organising laboratory instruction, and may not spend on this object one sixpence out of the thousands of pounds it receives as fees from candidates. *It simply pays those fees into the Treasury to relieve general taxation!*

Of its many defects, a most withering indictment was recently framed by Mr. H. G. Wells, the well-known *litterateur*, in the pages of the *Outlook*. He points out how the University library is practically inaccessible, owing to the room, intended as a reading room (where the books are locked up), being nearly always used for examinations—sometimes even for practical anatomy examinations, giving "a thin, permanent odour, of dogfish and rabbits about the place." Fancy dissection in a library! Mr. Wells's narrative is, however, too graphic to be dismissed quite so briefly:—

"Whiles this grey and grimy University is dusty, desolate, and empty; whiles great crowds of bearded young fellows, callow men, priests from Stoneyhurst and Dissenting ministers, medical students, Hindoos, Board School teachers, the cheap hacks of private schools, careless school girls, too careless to pass! and careful school-mistresses, too careful!

and a most variegated tag-rag and bob-tail of specially hired commissionaires and graduates in unaccustomed gowns, also (gowns and graduates) specially hired. . . . . Outside lurk the hirelings of such notorious crammers as Mr. Briggs and Mr. Kerin, and so forth, armed with handbills and such like bait to thrust into the candidate's hand."

The engineering candidate is, indeed, conspicuous by his absence, just as the crammer's candidate, who has been "prepared" by correspondence for the pass degree in Arts, is conspicuous by his superabundance. The only thing that the University can offer him—supposing he has passed matriculation and intermediate examinations—is a Bachelor of Science degree, to acquire which he must select to be examined in any three out of the following subjects:—pure mathematics, mixed mathematics, experimental physics, chemistry, botany, zoology, animal physiology, geology, and mental and moral philosophy. Engineering is simply ignored.

For some 15 years there has been on foot an agitation for reforming the University. Some have favoured the creation of a second separate teaching University in London. Others have worked to reform the existing University by trying to reconstruct it. The former plan has commended itself to some who bore little love for the old examining Board, and would have gladly seen it superseded by a modern rival. The latter plan has been advocated by those who had a real attachment to the University with all its defects, and did not wish to see it strangled by a younger rival. Two parties have grown up—those who desire to see the University reformed and reconstituted, and those who wish to see its examinations left severely alone, and the work of teaching and organising education in London given to a new University. It is 11 years since a charter for a second University was applied for and refused in Parliament. Since that epoch two Royal Commissions have sat upon the question, and both—one by a mere majority, the second unanimously—condemned the notion of two Universities, and recommended the reconstitution of the existing University.

The Bill now before Parliament is a Bill to create a statutory commission under Lord Davey, armed with Parliamentary powers to carry out in general the recommendations of the second Royal Commission, modified, however, by certain safeguards which have been introduced as a part of a compromise arranged by Sir John Lubbock and his friends to meet opposition. The scheme will create a new representative Senate, with boards of studies, an academic council, and a board to look after the interests of external students. It is supported not only by the present Senate and by the Convocation of Graduates, but by all the educational authorities in London affected by the Bill, the great Colleges, the Royal Colleges of Physicians and Surgeons, the Polytechnic Council, the Technical Education Board of the County Council, and by the Medical Schools. It is supported also by engineers generally, who desire to see the quality of instruction in engineering raised to a higher level. It is supported by the Royal Society, as tending to raise the value of degrees in science, and of science teaching in general; and it is supported by many old graduates because it will tend to rescue the University, and particularly the B.A. degree, from the lowered reputation into which it has fallen in consequence of the vast growth, during the past 20 years, of organised cramming. The rage for competitive examinations which overtook England a generation ago has left many deep traces in educational life. It has effectually crippled the University of London, and retarded the progress of higher education in London. Under its *régime*, the examination, which ought to have been a mere incident at the close of a well-directed course of studies, has become the end and aim of all. The natural course of training is perverted to the sole purpose of examination passing. Education is warped, and teachers hampered by the trammels of the system. Cram dominates all. The Bill now before Parliament, is but the first step toward the undoing of this disastrous state of things. Every engineer, civil, mechanical, or electrical, who desires to see the University of London reorganised on modern lines, should urge his Parliamentary representative to support the Bill.

Forms of Electrical Treatment.

THE memorable crusade against electrical quackery some five years ago was immediately followed by a distinct weakening of faith in electrical treatment. Unfortunately, the public memory is a short one, and we have for some time noticed a distinct revival at the hands of quacks of that blessed word, electricity. The claims of the Electrical Hospital of Notting Hill have not, until recently, met with the consideration which they merited; indeed, had it not been for the advertising medium of a coroner and his jury, there is a large probability that the institution would have long remained comparatively unknown. It is unnecessary to detail the whole of the circumstances that have brought the Electrical Hospital into prominence, but the main facts are that John Salter, an artist, aged 71 years, was found dead at 51, Peel Street, Kensington. The Coroner said "the deceased had received treatment at a so-called 'hospital,' by electricity, but the people being unqualified could not give a certificate, and an inquest was necessary. In some cases electricity was beneficial, but in others might aggravate a disease and accelerate death, which made it a serious matter. He could not understand why people did not go to a proper hospital for treatment." The evidence revealed the hospital to be an institution at Notting Hill, presided over by Prof. D'Odiardi, a name familiar to our readers, who claims to be a medical electrician. Certainly to our own knowledge this gentleman has been associated with medical electricity for a considerable period. It was admitted that the "Professor" had no medical qualifications, but that proved no obstacle to his treatment of consumption, throat affection, blindness, short sight, internal diseases, tumors, influenza, and special treatment of the voice for public speakers, &c. In the case of the poor aged artist he was treated at the Electrical Hospital for muscular paralysis and numbness of the legs, but according to medical testimony the cause of death was syncope. Apart from the very strong rider of the jury and the caution of the Coroner, the evidence given was remarkable, most striking developments in electro-medical treatment having apparently arisen at Notting Hill. Our readers are fairly well acquainted with the action of X rays, yet "Prof." D'Odiardi is actually using them in the treatment of disease. The Coroner, in his examination of one of the nurses, asked the following questions:—

> Nurses are sent out with apparatus, including that for the X rays?—Yes, for diseases; they did not take photographs.
> With what object?—We use them for the eyesight.
> For people who are blind?—Yes.

The "Professor," in his testimony, said he "found X rays useful in many diseases which caused a weak circulation. It re-animated capillary circulation." The cutaneous troubles arising from the application of X rays have been commented upon in these columns, and it has been necessary to devise methods to obviate them, yet here is an unqualified man pretending to treat blindness and other complaints by X rays, with probably disastrous results. The warning of the Coroner came not a moment too soon, and in the interests of genuine electrical treatment it is to be hoped that Mr. D'Odiardi will bear it in mind.

THE COST OF GENERATION AND DISTRIBUTION OF ELECTRICAL ENERGY.

(*Concluded from page* 471.)

Mr. Hammond next deals with the efficiency of the generating plant and refers to the great improvement which has taken place in the last ten years or so, and to the important place which must be assigned to this efficiency as a factor in the low cost problem. The conditions usually specified by him for steam consumption tests are quoted, and his method of fixing the amount of the penalty for any failure on the part of the contractor to obtain the guaranteed results is explained. We notice, however, that no mention is made of a bonus to the contractor if the latter succeeds in getting better results than those guaranteed, and we would suggest that the offer of a bonus, similar in amount to the penalty, would be a further inducement to manufacturers to strive after better results even than those which have already been obtained. A table of steam consumptions at full load for various plants tested under the conditions already specified is given, and reference is made to guarantees which have been given for plant now under construction; but we should have been glad to see figures quoted for the steam consumption at three-quarters and half load, as these latter are generally even more important for central station work than the full load figures.

In this connection, we would say a few words for governing by automatic expansion. We are well aware that Capt. Sankey and Mr. Morcom, in their valuable papers on the Willans and Belliss engines, have quoted tests showing that with these engines, although there may be some advantage in governing by expansion valve if the I.H.P. is taken as the basis of comparison, this apparent advantage disappears and the balance turns in favour of throttle valve governing when the more rational basis of consumption per B.H.P. or E.H.P. is taken. These results appear to be due to the considerably increased friction of the engine when governing by expansion, and this particular loss certainly has not the same relative importance in slow speed engines such as are used sometimes for large powers; whilst the facilities afforded by the expansion valve for arranging that the lowest consumption of steam shall occur at some other load than full load are much to its advantage, owing to the fact that the plant load factor during running hours can hardly be expected to average more than 75 per cent. We remember seeing a guarantee for a slow-speed compound-condensing engine, which seemed to us a good example of what is required for central station work. The normal full load output of this engine was 450 B.H.P., but it had to work up to 550 B.H.P. as an emergency load, and the guaranteed steam consumptions per brake horse-power and per hour were as follows:—20·9 lbs. at 150 B.H.P.; 18·2 lbs. at 250 B.H.P.; 17·6 lbs. at 350 B.H.P.; 18·1 lbs. at 450 B.H.P.; and 19·8 lbs. at 550 B.H.P. It will be seen that, making allowance for the dynamo efficiency, it is possible with such an engine to get an electrical horse-power at the dynamo terminals at any load between half and full load for a consumption which does not vary more than about 5 per cent.; that the best results are obtained at about three-quarter load, and that a 20 per cent. overload can be obtained with about 10 per cent. higher consumption.

In speaking of the efficiency of the generating plant, nothing is said about boiler efficiency, and yet there is no doubt that a great part of the difference between the coal consumption that can be obtained on a full load test, and that which is obtained in practice as the average of the year, must be debited to losses in the steam raising plant. We believe that it is the practice in many stations to measure the feed water by meter, and to enter up the amount registered every 24 hours, and we hope that in the discussion some information may be given as to the efficiency of the boiler plant under different conditions of working as regards output and load factor. Various schemes for thermal storage have also been brought forward in the last few years, and we should like to know if any hopeful results have been obtained from them in practice, and whether there are any prospects of a better all-the-year-round efficiency of the steam raising plant being obtained in the near future.

When speaking of efficiency of distribution, Mr. Hammond refers to the various views held by engineers as to the headings under which the difference between units generated and units sold should be entered, and states that in some cases the units used for magnetising or lost in the batteries are entered under the heading of units used on the works. That there should be any engineers who so misunderstand the meaning of the Board of Trade form is certainly surprising, as the magnetising units can no more be counted as units generated than those which are spent in overcoming the resistance of the armature or in iron and frictional losses in the machine; whilst the units lost in the battery should undoubtedly be debited against distribution. We agree with Mr. Hammond that the form used by the Westminster and St. James's Companies is an improvement on that prescribed by the Board of Trade, but we think that another column under the heading of units utilised might be added with advantage, so that the units used at the generating station for lighting might be separated from those used for power purposes, such as driving feed or circulating pumps, mechanical stoker gear, or elevators for raising coal. We suggest this addition because such electric motors take the place of engines that would otherwise be drawing steam from the boilers; and, since the units utilised in this manner are again used for generating purposes, they cannot strictly be included in the net units generated.

In the table given in the paper showing the ratio of the units used in distribution and unaccounted for to the total number generated, there will be found a striking difference between the losses in the low pressure and high pressure systems, and also between the maximum and minimum values of these ratios for the various undertakings working on the same system. For example, for the year 1896, we find that the average value of this ratio for low pressure systems is 8·3 per cent., the maximum 14·09 per cent. (at Southampton in the sixth year of working), and the minimum 2·32 per cent. (at Hull in the fourth year of working); whilst for high pressure systems the average value of this ratio is 26·2 per cent., the maximum 39·88 per cent. (Newcastle District Company in its sixth year), and the minimum 9·38 per cent. (Reading in the second year of working).

With regard to the question discussed in the paper, as to whether the coal bill can be considered in any way a reliable test of the all-round efficiency of an undertaking, it is evident, as is pointed out by Mr. Hammond, that neither the actual cost of fuel nor the weight of fuel consumed per unit sold can be taken as a satisfactory basis of comparison, owing to the great differences in the average price paid by the several undertakings, which ranges from less than 5s. to more than 20s. per ton, and to the difference of quality which naturally increases the weight consumed when cheap fuels are used. We must add that we do not think that a comparison of the thermal units in the fuel consumed per electrical unit will help us much, as with different qualities of fuel, the actual evaporation which can be obtained under the most favourable circumstances is not proportional to the calorific values of the fuels as determined in the laboratory; indeed, this difference may be very considerable, as the percentage of the total thermal units that can be utilised for evaporation may, with some fuels, be more than 50 per cent. greater than it is with others. To get a really fair basis of comparison, it would be necessary to make a series of tests of actual evaporation with the various qualities of fuel burnt in boilers of the several types used in central stations, so as to get for each fuel a figure which would represent the best possible evaporation that could be obtained with it.

It must, however, be remembered that the engineer in charge of a station often finds plant already in service, and that the task which is set before him is to get the best possible efficiency out of the existing plant, and that he has not the chance, perhaps, of replacing it by other plant which could give a better result. Under these conditions, the all-round efficiency which is interesting to him is expressed by the ratio of the average weight of fuel actually consumed per unit sold, to the weight of fuel necessary to produce a unit at the dynamo terminals under the best possible test conditions. We would, therefore, recommend that in all works tests should be made on full load with the usual quality of fuel, and that the engineer should always keep the results of this test before him as the ideal consumption to which he

has to approach as nearly as possible; and that tests of 24 or 48 hours' duration should be made under working conditions at various seasons of the year, so that the relative importance of the several losses under different conditions may be ascertained.

In the course of his paper Mr. Hammond quotes the ideal costs given by Mr. Crompton in 1894, and also tabulates some ideal costs made up by taking the best results for each item obtained by any works and combining all these records in one undertaking, and then discusses the probabilities of any works obtaining equally good results. He also concludes his paper with a prophecy as to the cost per unit at Leeds when the output reaches 5,000,000 units, and we propose to conclude these notes by a few remarks on this subject. As regards fuel consumption, it is unfortunate that Mr. Hammond has not given us any information as to the weight of fuel now used per unit at Leeds, nor as to its calorific value, so that it is difficult to get a correct appreciation of what is really represented by his prophecy, that the cost of fuel will be $\frac{1}{5}$th of a penny per unit when the output has reached 5,000,000 units. He speaks, however, in another part of his paper of its being possible to compare the coal results of works drawing from the same coal fields, such as Bradford and Leeds; and if we are to assume that the price at Leeds is about the same as that given for Bradford, the prophetic figure means a consumption of under 5 lbs. of fuel per unit sold. This appears to us to be a figure which will be difficult of attainment, unless the increased output is accompanied by a considerable improvement in the load factor; as, if this latter remains at about its present value, at which the units sold are only 70 per cent. of those generated, the consumption of fuel per unit generated will be under 3½ lbs.

An examination of the tables of fuel consumption shows us that we are still a long way off Mr. Crompton's ideal of 2½ lbs. of Welsh coal, the best result quoted in them being the 5·8 lbs. at Oxford, followed by the St. James's, Westminster, and Kensington companies, with 6·4, 6·5 and 6·6 lbs. respectively. Improvements may be made by the use of larger and more efficient generating units; but so long as the load factor remains at its present low figure, we believe that the stand-by losses in the boilers and condensation in pipes will prove the great obstacle to a reduction even to 4 lbs. of Welsh coal, no matter how much the actual output may be increased. Wages will also be diminished by the use of larger units, and automatic machinery for handling coal, but so far the best result is that obtained at Edinburgh of ·20d., or double the ideal cost proposed by Mr. Crompton; and the same difficulty will be experienced in reducing this item if the maximum demand on the works increases in anything like proportion to the output.

With regard to repairs and maintenance, we have already pointed out that the figures for stations which have been running for several years do not show such a great reduction in this item; and, although there is every reason to believe that Mr. Crompton's figure of ·35d. per unit may be improved on, we think that Mr. Hammond underestimates this item when he puts it at only one-tenth of a penny in his prophetic costs. The last items, rent, rates, taxes and management are beyond the control of the engineer, and depend to a great extent on local circumstances. We have already shown that with some of the most important undertakings, the tendency is towards a very slight decrease, and in some cases even there is an increase in this item; and there is nothing in the statistics published by Mr. Hammond to lead us to expect very material reductions. On the contrary, we know that there is a tendency on the part of local rating authorities to increase the assessment on electric light stations far more rapidly than is pleasing to the proprietors; that rents are proportionately higher if a station has to extend beyond its original boundaries and acquire leases of neighbouring property; that engineers and managers all hope for a substantial increase of salary with the growing importance of the undertaking; that the expenses of reading meters and collecting payments increase and that directors' fees have to be provided as the undertaking becomes more successful. We are, therefore, of opinion that Mr. Hammond's prophecy is somewhat too optimistic, but at the same time, we sincerely hope that he may be able in a few years to show us that we are wrong, and we can assure him that we shall only be too glad when the time comes that we can congratulate him on the fulfilment of his prophecy.

SOME NOTES ON SINGLE-PHASE MOTORS.

By A. C. EBORALL.

(*Concluded from page* 433.)

It will be seen that these motors show high power factors and efficiencies even at low loads, while the drop of speed is very little. These good points are well brought out in fig. 17, which gives a test of a 2-H.P. Kolben motor designed to

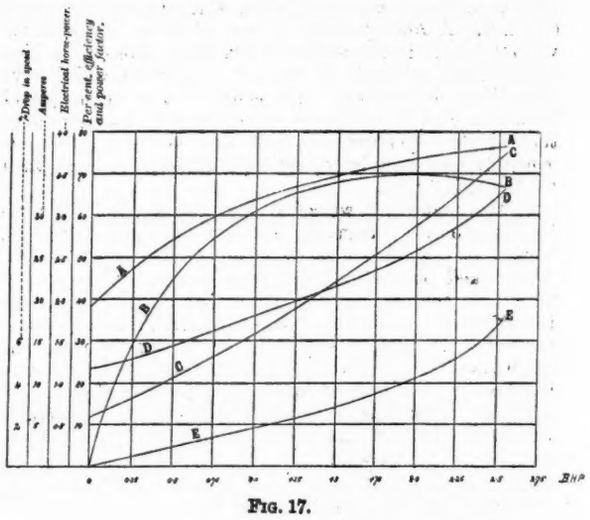


Fig. 17.

run at 1,500 revolutions per minute on a 50 ~ 110-volt circuit. The curve marked A A shows the percentage power-factor, B B the percentage efficiency, C C the electrical horse-power absorbed, D D the amperes at 110 volts, while curve E E gives the percentage drop in speed. The general

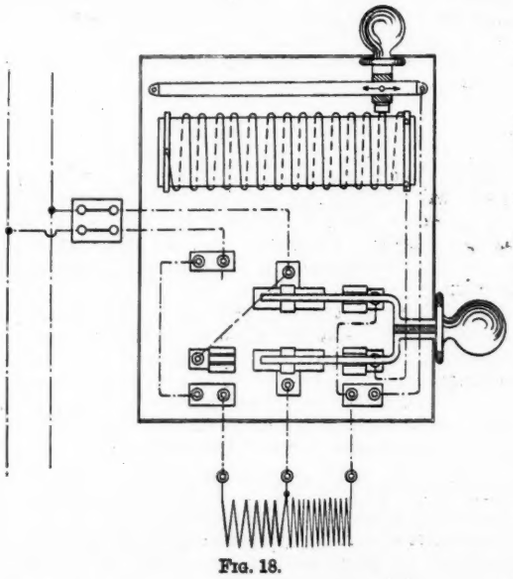


Fig. 18.

design of the Kolben motors is not very different to that of Messrs. Brown. The semi-rectangular stator holes used have already been noticed. Another point is that the stator core discs are magnetically separated from the case in which they are built in. This not only minimises leakage from

the stator, thus tending to improve the power factor and the starting, but at the same time better ventilation is secured. The stator is drum wound with flat coils, as in fig. 8. The smaller motors up to 8 H.P. are all built with plain rotors, and are started up in a manner similar to that shown in fig. 12A, a non-inductive resistance being used instead of the condenser. The particular arrangement used is well shown in fig. 18, from which it will be noticed that the resistance is capable of being adjusted for different starting currents and torques. Motors above this size have a three-phase winding on the rotor, whose ends are connected to slip-rings as before described. They start up with the same device used in conjunction with a non-inductive rotor resistance. Fig. 19 gives the winding scheme of such a rotor for a 20-H.P. six-pole Kolben motor for a low tension circuit at 50 ~.

Mr. Kolben has recently been carrying out experiments with large motors, using mica condensers, which latter seem to promise the best results, not only for high pressure motors, but also for those working at low voltages. In this last case the pressure is transformed up by a small converter for the starting phase, as shown in fig. 20. A non-inductive resistance is, of course, used in the rotor. After the motor has run up, the transformer is switched off. In order to make

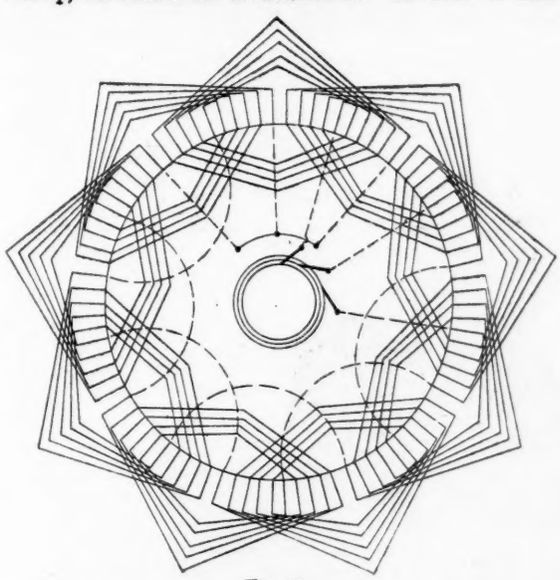


Fig. 19.

the motor perfectly safe under normal working conditions, the starting winding of the motor is made in two sections,

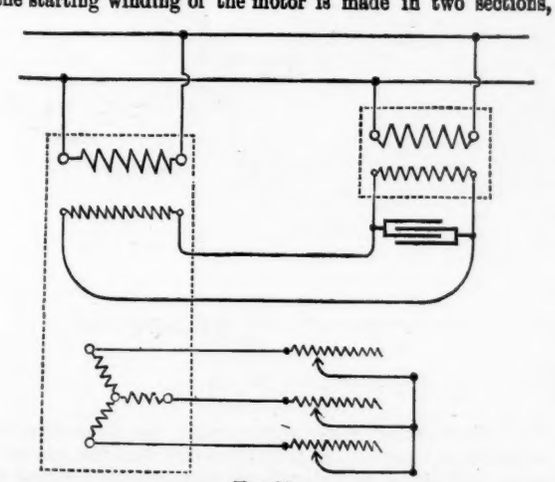


Fig. 20.

which are cross-connected after the motor has started and the transformer switched out, for otherwise the field of the working winding would produce a constant high pressure in the starting coils. A transformer would not be necessary in those

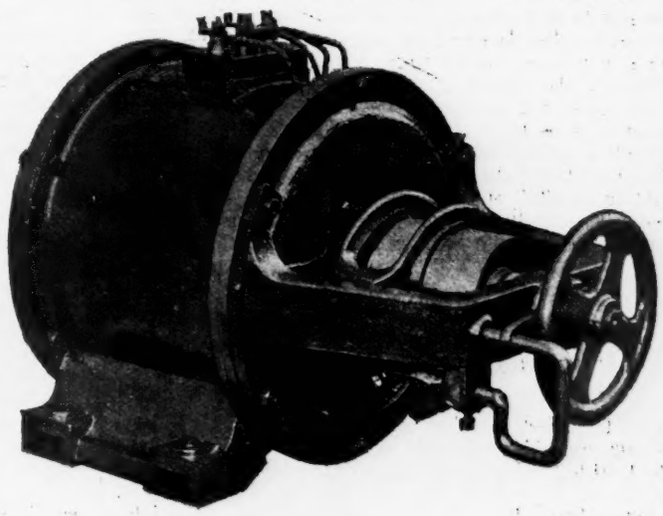


Fig. 21.

places where the high pressure circuit is directly available. This method of starting should prove very effective for high frequency motors.

It is worthy of note that in the case of high pressure Brown motors, the high pressure is reduced for the starting windings and condenser, while for the Kolben motors the high pressure is directly utilised; and if not available directly, is obtained by transforming up. This is, of course, because in the first case the condenser is of the liquid type, acting by electrolytic polarisation, and cannot stand a high voltage; whereas, in the second case, it is an ordinary condenser, and becomes smaller for the same effect as the voltage is raised.*

Fig. 21 shows one of Messrs. Kolben's 6-H.P. motors with fast and loose pulley.

(*D*) *The Allgemeine Elektricitäts Gesellschaft.*—This firm (the pioneers of multiphase working in Germany) have of late years been turning their attention to single-phase induction motors, and with very satisfactory results. Their design is on the same lines as those of the other firms mentioned above, but with a special starting winding used in conjunction with a non-inductive resistance. Mr. Stöttner, the manager of the company's London branch, recently showed the present writer two motors satisfactorily working at 100 ~ under trying conditions—one was comparatively small, the second, of nominal 6 H.P., driving a circular saw of large size. They were both working wonderfully smoothly, the latter hardly emitting any noise when fully loaded. This is rather a common characteristic of high frequency motors of any size, being most prominent at starting. The motor in question started up very quietly indeed, taking about 60 seconds to reach full speed on the loose pulley.

The single-phase motors noticed above are the only ones that have had a lengthy practical trial and been uniformly successful. Many others have been designed by various people, and with various schemes, to make them self-starting, but it remains to be seen whether they are capable of being successfully operated in any but toy sizes.

Single-phase motors of the induction type have undoubtedly solved the problem of power distribution from ordinary lighting circuits. It is true that all those in successful operation are of Continental make, but then the demand for power is much greater there than here, and must be satisfactorily met. And, as a rule, the alternate current generators on the Continent are much better able to take care of a combined light and power load than is the case in England, where the generators generally regulate extremely badly on any load containing self-induction. That this poor regulation on inductive loads is unnecessary, is shown by the case of Frank-

* Current through condenser = $2\pi n \kappa \times$ the secondary E.M.F. of transformer. Hence if the condenser is to give a particular current, both a high frequency and high E.M.F. tend to reduce its size.

furt, where the lighting is quite as good as in any English town, despite the fact that motors of all sizes (including several of 70 H.P.) are running on the lighting circuits. The present writer was assured by the engineer of the Frankfurt station that the motor load gave him no trouble whatever; in the case of the large motors, he, of course, knew when they were coming on.

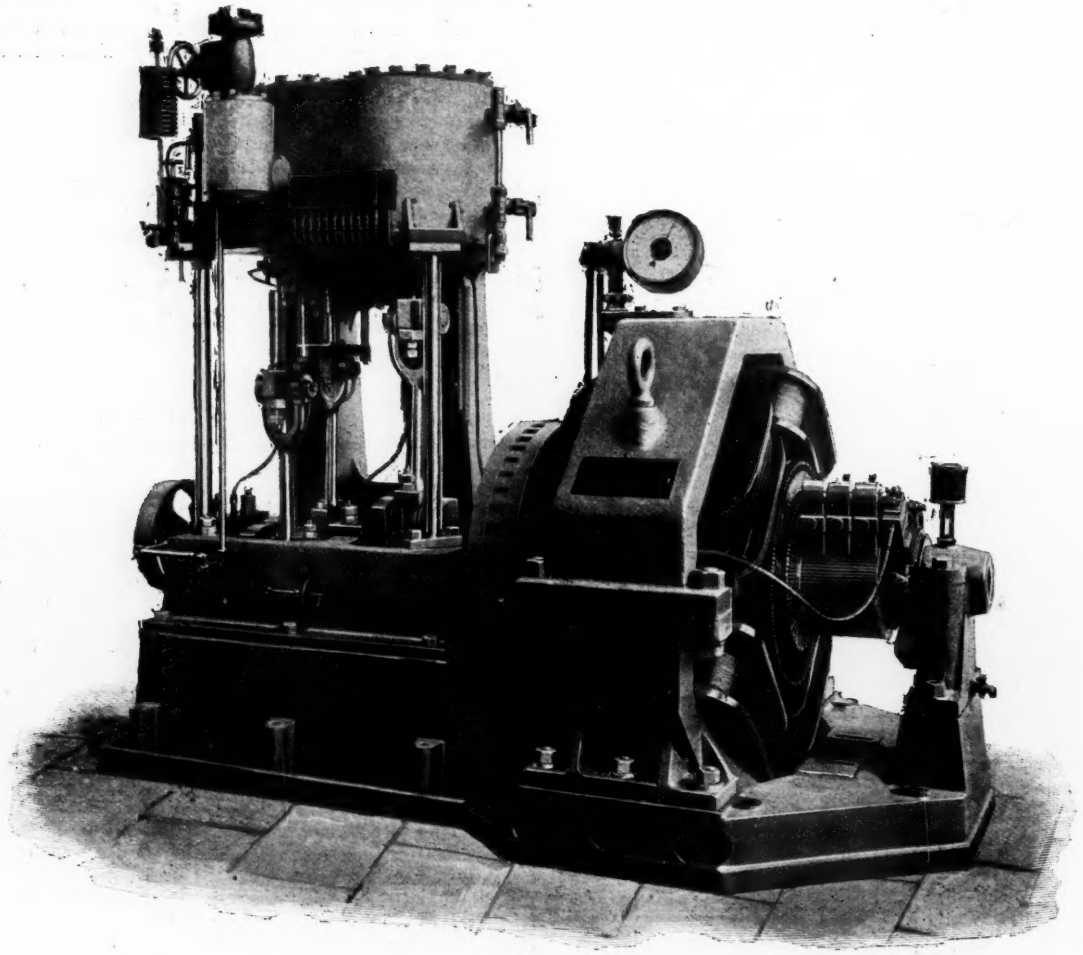
In conclusion, considering the excellent performance of motors such as those of Brown, Kolben, &c., it is rather difficult to understand why the common complaint heard so often here, that "alternate current motors cannot be run on lighting circuits" should exist. It is to be hoped that this complaint will disappear, as the present tendency to adopt reasonable frequencies becomes more general in this country.

THE LIGHTING OF WARSHIPS.

With the object of reducing the external magnetic leakage of dynamos, which was liable to affect the ship's compasses, the British Admiralty some years since made trial of a two-pole ironclad type of dynamo. This form of machine was, however, found heavy, and in order to reduce the weight, while at the same time keeping the magnetic leakage at a minimum, the Admiralty have now adopted a multi-polar machine. The illustration represents an 80-volt 600-ampere set running at a speed of 300 revolutions per minute, lately supplied by Messrs. W. H. Allen, Son & Co. for H.M.S. *Amphitrite*. The armature is of the series-wound drum type, the current being collected by two sets of brushes placed 90° apart. The core is secured to the shaft by means of a cast-iron spider, open at each end to allow free access of air, so as to ventilate the armature thoroughly. The commutator is built up of hard drawn copper sectors, and is insulated everywhere with mica. The magnets are of high permeability, cast-steel throughout, and consist of a yoke ring with four radiating poles projecting inwards bolted to it. The yoke ring is in two halves, the division being on the horizontal diameter, allowing of the easy removal of the armature without in any way disturbing the magnetic coils. The latter are wound on formers so that they may be readily removed or replaced.

The engine, which, with its dynamo, is mounted on a combination base plate, is of the compound vertical double-acting type, having cylinders 7½ inches and 15 inches diameter × 9 inches stroke. The working parts are of steel, having a tensile strength of 30 tons with an elongation of 27 per cent. in 2 inches. The bearings have white metal linings. The engine is constructed for a working steam pressure of 300 lbs. per square inch. The steam consumption upon trial at the makers' works was 26 lbs. per electrical horse-power per hour, with a steam pressure of 200 lbs. per square inch, when exhausting into the atmosphere. The maximum temperature rise of the machine after a six hours' full load trial did not exceed 65° F. above the temperature of the surrounding atmosphere. The difference in weight between the four-pole set and an ironclad two-pole of the same output is over 2½ tons.

Sets of a similar type, but for 400 amperes, have been supplied by this firm to H.M. ss. *Hermes*, *Highflyer*, and *Hyacinth*.



INDUCTANCE IN TELEPHONY.

By W. MOON.

The effects of inductance together with that of electrostatic capacity are more important in telephony than that of resistance. The effect of a distributed capacity, as it occurs in practical telephony, it is impossible to calculate. But if the inductance of the circuit be dealt with apart from capacity,

the figures are not difficult, and I propose in the present paper to deal only with such inductance effects.

The inductance of a piece of apparatus can be readily measured by Maxwell's method, fig. 1.

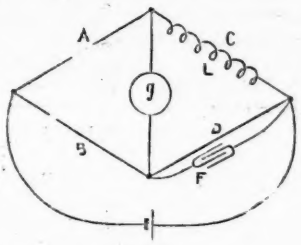


Fig. 1.

The bridge should first be balanced for steady currents, without any capacity in the condenser, and a deflection read "q_L" on closing or opening the battery circuit. The apparatus in arm "C" should then be replaced by an inductionless resistance which should be adjusted to obtain a fresh balance for steady currents, and a reading "q_F" taken on opening the battery circuit from the discharge of the condenser.

If then the arms "A" and "B" are equal

$$L = \frac{q_L}{q_F} F D^2.$$

There is no advantage to be gained by using unequal values in the arms "A" and "B" of the bridge.

The mutual induction of a piece of apparatus can be best measured by comparing the discharge "q_m" from the secondary circuit, when the primary circuit is closed, with the discharge from a condenser "q_F" through the galvanometer, as shown in fig. 2, where the secondary coil is first joined to the

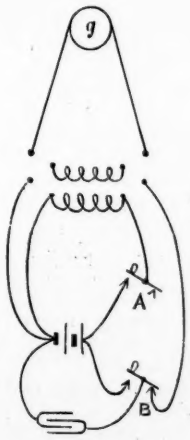


Fig. 2.

galvanometer, and the discharge taken with key "A," and a discharge afterwards taken from the condenser through the galvanometer with key "B."

$$\therefore q_m = M \frac{E}{R S} \text{ and } q_F = E F$$

$$\therefore M = \frac{q_m}{q_F} F R S,$$

where "M" is the mutual induction, "R" the resistance of the primary circuit, "S" that of the secondary circuit, and "F" the capacity of the condenser.

In double wound coils, the inductance of each coil and the mutual induction between them is the same. And as mutual induction can be more readily measured than self-induction, it is sometimes convenient to specially double wind particular coils in order to obtain their self-induction from the measured mutual induction.

When the battery is reversed between each measurement of mutual or self-induction, the deflection on closing the battery circuit is always greater than that of breaking it. This is due to the effects of the residual magnetism The two deflections being proportional to "$c\,a$" and "$c\,b$," and the residual magnetism effect to "$b\,a$" on the magnetisation curve, fig. 3.

Thus the inductance for alternating currents should be measured by reversing the battery while the balance is

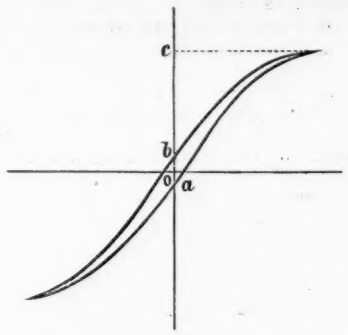
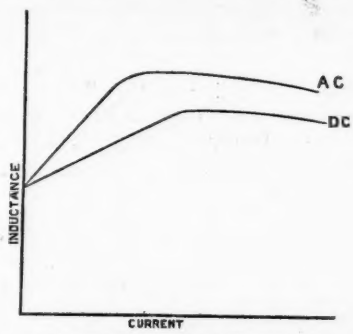


Fig. 3.

steady, or half the sum of the deflections, on opening the battery circuit, reversing the battery, and closing it again, may be taken. While for single current working the inductance should be measured by the deflections produced on opening the battery circuit only.

In all apparatus containing iron the inductance varies with the strength of the current used; and the inductance is greater with alternating currents than direct ones. But



A C, alternating current; D C, direct current.

Fig. 4.

with very small currents the difference between the inductance with alternating and direct currents is very small, as shown in fig. 4.

And the inductance for telephonic currents is not much less than that of the smallest currents by which the inductance can be measured.

The following list of inductances is for telephonic currents:—

	Henrys
Nonpolarised relay 1,000$^\omega$	4·9
Polarised indicator relay 1,000$^\omega$	8·6
Telephone galvanometer 4,000$^\omega$	52·
Magneto bell 1,000$^\omega$	15·
Switchboard telephone 75$^\omega$	·01
Bell telephone 150$^\omega$	·1
Self-restoring indicator local circuit 250$^\omega$	·64
Self-restoring indicator line circuit 1,000$^\omega$	17·5
Telephone transformer 250$^\omega$ each coil	3·5
Triple wound transformer primary 150$^\omega$	5·
Triple wound transformer each secondary 1·0$^\omega$ ...	·73
Telephone induction coil 250$^\omega$	1·75
Telephone induction coil, mutual induction	·016

When the resistance and inductance of a circuit are known the impedance can be calculated from the formula

$$I_m = \sqrt{R^2 + p^2 L^2}$$

where $p^2 = (2\pi n)^2$ and n is the number of pulsations per second.

In telephony "p" depends on the pitch of the voice, and hence there is a maximum and minimum impedance. For male voices n ranges between 90 and 140 pulsations per second. And for female voices between 280 and 560 per second. So that for male voices $p^2 = 320{,}000$ to 770,000, and for female voices $p^2 = 3{,}095{,}000$ to 12,400,000. And a maximum and minimum value of p^2 might be taken as 12×10^6 and 3×10^5 and a mean value as 2×10^6. Or for rough calculations p^2 may be taken as 10^6.

A number of telephonic apparatus are used as a shunt across others; the joint impedance of two such circuits is :—

$$I_m = \sqrt{\frac{(R^2 + p^2 L^2)(R_1^2 + p^2 L_1^2)}{(R + R_1)^2 + p^2 (L + L_1)^2}}$$

where "R" and "L" are the resistance and inductance of one circuit, and "R_1" and "L_1" that of the other.

The proportion of the whole current passing through "R_1"

$$= \frac{\sqrt{R^2 + p^2 L^2}}{\sqrt{R^2 + p^2 L^2} + \sqrt{R_1^2 + p^2 L_1^2}}.$$

Thus, an induction coil and Bell receiver in series having a resistance of 300$^\omega$ and an inductance of ·25 henrys would have an impedance on short-circuit of

$$\sqrt{300^2 + 3 \times 10^5 \times \cdot 25^2} \text{ to } \sqrt{300^2 + 12 \times 10^6 \times \cdot 25^2}$$
$$= 330 \text{ to } 916 \text{ ohms},$$

and an indicator relay of 1,000$^\omega$ and 10 henrys would give 5,560 to 34,700 ohms.

So that if the indicator relay is used as a shunt across the telephone and induction coil it would take

$$\frac{330}{330 + 5{,}560} \text{ to } \frac{916}{916 + 34{,}700}$$

= ·056 to ·0257 of the whole current.

A magnetic bell of resistance 1,000$^\omega$ and inductance 15 henrys, if used as a shunt across a circuit would give an impedance of 8,250 to 52,000 to speech, but only an impedance of 1,800$^\omega$ to the current from a magneto generator when p^2 is taken as 10^4.

The principle of mutual induction enters largely into telephony as apart from the use of transformers for joining a single line on to a looped one, or their use in superimposed circuits; the telephonic induction coil acts as a transformer and may be regarded as such. Also the iron cores and iron sheathing of coils act as secondary circuits of small resistance and inductance.

The current "x" in the primary circuit and that "y" in the secondary circuit of a transformer are given by the formula

$$x = \frac{E_m}{\sqrt{(R + \nu S)^2 + p^2 (L - \nu N)^2}} \qquad (1)$$

$$y = \frac{E_m \sqrt{\lambda}}{\sqrt{(S + \lambda R)^2 + p^2 (N - \lambda L)^2}} \qquad (2)$$

where "R" and "L" are the resistance and inductance of the primary circuit, "S" and "N" that of the secondary circuit, "E_m" is the mean electromotive force apart from phase.

$$\lambda = \frac{p^2 M^2}{R^2 + p^2 L^2} \text{ and } \nu = \frac{p^2 M^2}{S^2 + p^2 N^2}$$

where "M" is the mutual induction.

The current, "I," without the transformer in circuit would be

$$I = \frac{E_m}{\sqrt{(R_1 + S_1)^2 + p^2 (L_1 + N_1)^2}} \qquad (3)$$

where the quantities in the denominator are reduced by the values of the resistances and inductances of the transformer.

To get the best effect from a transformer, obviously the primary and secondary coils should be so wound that its primary resistance and inductance should be in proportion to the resistance and inductance of the primary circuit, and its secondary resistance and inductance in proportion to the resistance and inductance of the secondary circuit.

(*To be continued.*)

THE WELSBACH INCANDESCENT ELECTRIC LAMP.

By A. M. GIBSON.

So much has been written and spoken in a vague way about the latest invention of Dr. Auer von Welsbach, and such great expectations have been raised as to its ultimate commercial value, that all who are interested in the progress of electric lighting will welcome some definite information on the subject.

The following particulars are taken from the complete specification which has been "laid open for public inspection" by the Hungarian Patent Office at Buda-Pesth.

Two kinds of glow-bodies for use in incandescent electric lamps, with several different methods of producing the same, are described in this patent application. The first is a fine filament of osmium of a peculiar form. As is well known, osmium is one of the platinum group of metals. It usually occurs as a compound known as osmiridium, in flat, irregular grains, and sometimes in hexagonal prisms. In the separation of the iridium and osmium, the latter is generally found to contain ruthenium. It is easy to obtain the pure osmium from the ruthenium compound on account of the affinity osmium has for oxygen, the tetroxide, $Os\,O_4$, forming readily. The tetroxide is, however, extremely volatile, and the fumes given off in reducing by volatilisation to obtain the pure metal, are very poisonous. The vapour of tetroxide destroys sight if the eyes are exposed to it.

The second filament is one formed from thoria, the earth metal oxide so largely employed in the preparation of incandescent gas mantles.

Dr. Carl Auer von Welsbach has worked out several different methods of obtaining his osmium and thoria filaments, but so far these methods are merely laboratory processes. Lamps, it is true, have been made which, according to Dr. Auer, give very remarkable results, and he claims that a phenomenal high efficiency lamp, with a long, economical life, can be produced. While the inventor has not made any public statements as to the exact efficiency and life of his filaments, it is reported, on no particular authority, that the wattage per candle is under 2, and even as low as 1·5.

Osmium has never been fused. At the point at which iridium melts the osmium goes off in fumes, which take fire in the air and form tetroxide of osmium. It is possible to obtain it in an amorphous powder which can be converted into crystals. Osmium is the heaviest of metals, its specific gravity, determined from the crystalline form, being 22·477. It is undoubtedly the most refractory metal.

Dr. Auer claims that osmium does not volatilise at the highest temperature obtainable if confined in a vacuum or if surrounded by reducing gases. He does not make clear what he means by surrounding with reducing gases, but presumably it is that the gases are present in such a way as to exclude oxygen, because it is undoubted that with free access of oxygen osmium does vaporise.

One of the methods Dr. Auer employs to obtain his osmium filament he describes as follows:—A platimum wire of 0·02 mm. diameter is fixed in a vacuum surrounded by vapour of hydro-carbon, greatly diluted with water into which small quantities of tetroxide of osmium are blown from time to time. The wire is glowed in this atmosphere, and a thin layer of metallic osmium is deposited thereon. The deposit must be effected slowly, and from the context of the description of the process it inferentially appears that a number of very thin layers must be obtained. There is difficulty in obtaining perfectly uniform deposits, anything like warts, or nodules, of course, would affect the regular resistance of the filaments. The fragility of the coated wire as it comes from the flashing apparatus is admitted to be great, because the layers contain some oxide, *i.e.*, the layers are not in this stage pure metallic osmium. Therefore the glowing is continued until the very thin platinum core is volatilised, and the osmium coating becomes homogenous, and you have a tube of pure osmium. This is described as being elastic and nearly the colour of platinum.

The coating may also be effected by drawing the fine platinum wire through a solution of a sulphide or tetrahydroxide of osmium, and then glowed in a vacuum. If this method is employed, the operation must be repeated at

least 100 times, in order to obtain the requisite thinness of layers.

There is also an electrolytic method mentioned, but there is no description of the method of preparing the electrolyte of osmium, or of the current required in this operation. It is, however, stated that the glowing of the wire must be carried out as in the other methods after the electrolysis is concluded. This part of the specification is exceedingly vague; but before a German or an American patent is obtained, fuller explanations of the electrolytic method will doubtless have to be supplied.

Vegetable or animal fibres can also be employed as the foundation for the osmium coating. A liquid pulp is made by mixing the finely triturated osmium oxide with sugar, or organic cementing material and water, and the impregnated thread of fibre, after drying, is brought into the required shape for the lamp, and slightly glowed in a reducing atmosphere. From this it appears that the osmium particles secure conduction. A carbon skeleton, carrying osmium unconsolidated, is thus obtained. It can be fixed in the lamp bulb, which is filled with reducing gases, and the glowing proceeds slowly, steam being also admitted to the bulb. The intensity of the current is gradually increased, until a very high temperature is reached. To secure uniformity of resistance, the filament so produced is normalised by flashing in a vapour of tetroxide of osmium and hydro-carbon.

Nitro-cellulose may also be saturated or mixed with pulverised pure osmium—the amorphous form, of course—or sulphide of osmium, or tetrahydroxide, and the mixture is then formed into threads by squirting, or otherwise, denitrated, and heated in the same manner as the fibres.

Instead of cellulose or fibres, a soft, slightly twisted cotton thread may be impregnated in a thin pulp of finely divided osmium sulphide and water, mixed with a cementing medium, as, for instance, sugar. The thread is dryed, and then carbonised in a reducing gas, such as illuminating coal gas.

Dr. Auer's method of obtaining his thoria filament is interesting. He states a fact which is not generally known, but which is quite true. A platinum wire brought to a white heat by an intense current, or other means, melts. A very thin platinum wire held in the hottest zone of a Bunsen gas flame will melt; but if the wire is coated with a firmly adhering cover of thoria, it will not melt at any measurable temperature. This is due to the fact that a great part of the heat energy, coming in contact with the absolutely fireproof material covering the wire (for instance, in the Bunsen flame) is converted into light radiating energy, or light emissiveness. This is as equally true of electric energy as with the gas flame. The intense power of the cover to emit light and heat withdraws energy from the metallic conductor.

Gradually raising the energy in intenseness, a dazzling white spot of light will occur at a place in the filament, and spread slowly (sometimes quickly) over the whole length. About this time a minute ball will be seen by the close observer to spring from the thread. This phenomena is caused by the volatilisation of the thin platinum core under the intense heat obtained by increasing the current tension. There is now left a tube of thoria, which will withstand still higher current tension, and the brilliancy of the light emission increases correspondingly. The curious part is, that at a current tension which fuses, or destroys any other substance, there is very little heat radiated by the brilliantly incandescing thoria filament. Continuing the increase of current tension, a point is reached at which the thoria tube bursts with a slight explosion. The thickness of the thoria cover need be but some tenths of a millimetre. A mere film will answer, in which case the colours of the rainbow will, at one stage of the experiment, appear.

It is evident, although not so stated in the specification, that the thoria covering must be dense, and in no wise porous. To obtain such a covering is exceedingly difficult.

Dr. Auer states vaguely that he uses "a preparation of thorium, which gives back an oxide when being glowed." A nitrate or a selenate of thorium will do this. The process described in the specification of forming the cover, doubtless, will answer in the laboratory, but in manufacture upon a commercial scale it must inevitably prove impracticable. The thin platinum wire 0·02 of a millimetre in diameter, approximating to the tennity of the split cocoon silk filament, is drawn through elastic cheeks, which are moistened with the solution of thorium. After each drawing the wire is glowed. The drawing through the moistened cheeks, and the glowing, must be repeated at least 50 times. To reach perfection by this method the solution employed to moisten the cheeks through which the wire is drawn, must be very dilute, and the drawing and glowing must be repeated several hundred times. A wire of a compound of platinum and osmium answers better than pure platinum, because more infusible. A compound wire of platinum osmium, ruthenium and rhodium or iridium, answers better than platinum.

It is to be noted that in practice the platinum core is not volatilised. The experiment above described is merely to illustrate the enormous heat resistance of pure thoria.

Although not expressly stated in the specification, it is evident that the best results can only be obtained with the filaments of Dr. Auer by the employment of alternating currents.

The cost of producing either the osmium or the thoria by the processes described must be considerable. Platinum wire costs in proportion to the tenuity to which it is drawn. Ordinarily pure platinum costs, say, 50s. to 55s. an ounce. To draw down to 0·02 of a millimetre adds enormously to the price, for workmen can only be engaged in the operation a few hours on account of the strain upon their eyesight, to say nothing of the other difficulties encountered in the drawing. Then the repeating the process of coating and glowing several hundred times, no matter what mechanical devices are used, means great expense. It is true many filaments are obtained from 1,000 metres in length, but incandescent electric lamps are produced by the million.

There is one noticeable feature of Dr. Auer's specification, and that is the omission in the descriptive part to allude to the electrolytic way of producing on a platinum core, or any other conducting core, a dense, firmly adhering thoria coating or covering. It is well known to a limited number of experts, who have experimented with thoria, that such a coating or covering can be obtained by electrolysis. This coating can be deposited on platinum in any desired thinness from an electrolyte properly prepared, and readily and comparatively cheaply. Dr. Auer mentions the electrolytic way of securing his osmium coating, but for some reason he does not mention in the body of his specification the electrolytic method of obtaining a thoria coating; nevertheless, in his claims he very adroitly covers, indirectly, in the Hungarian patent, the electrolytic process of coating with thoria. Why this indirection?

Because the electrolytic way is not patentable!

Neither is it new that thoria is an absolutely fireproof material, nor is it novel that a very slight coating of thoria protects platinum from the effect of high temperature by transforming heat energy into light emission.

It is not new that platinum wire coated with an enamel-like covering of thoria has an enormously increased electrical resistance, and consequently a minimal volume of high tension current will give intense light emission.

CORRESPONDENCE.

Recent Smashes at Brighton.

In the Electrical Review, appearing rather ominously on April 1st, there appears an alarming report to the effect that Mr. Crompton distinctly stated in his speech at the Institution last Thursday evening, that there have been recently a great many smashes at the Brighton Electricity Works, and implied that these were due to the use of high tension steam dynamos, and to the breaking of steam pipes. Perhaps it will be sufficient for me to say briefly:

1. There have been no smashes at Brighton recently, or during the last seven years.
2. High tension steam dynamos are not used at Brighton.
3. There are no steam pipes in proximity to high tension apparatus.
4. No breakage of steam pipes has occurred.

From the above, it is very evident that there is a "Nigger" somewhere in the reported speech of Mr. Crompton, who is the very last person to intentionally mislead his audience.

Arthur Wright.
Per L. A. D.

Weatherproof Wire.

As a subscriber for four years past to the Electrical Review, as well as the writer of the article on "Weatherproof Wire," noticed in your editorial of March 11th, I suppose I should answer the questions asked in the latter part of the editorial.

To the first one, "How it is possible to maintain such circuits in wet weather?"—the inquiry referring to the so-called weatherproof wire strung in the ordinary American fashion on glass insulators—I beg to reply that so long as the wires remain on the insulators and do not swing into contact with other conductors or semi-conductors, the maintenance of the circuit presents no difficulty. The insulation resistance of such a circuit is, of course, proportional to the number of insulators, and the resistance per insulator depends on the shape and size of the insulator, but is usually above 10 megohms during and after a soaking rain. With poles spaced 50 per mile, the total leakage from a line of any ordinary length is of no commercial consequence. If concentrated on one insulator it might become of consequence by breaking down the insulation, but the leakage is not concentrated and the glasses do not break down in practice.

The result of such construction is, in wet weather, a line of low total insulation but of sufficiently high insulation at each point of support; in other words, a line on which the leakage is uniformly distributed. This condition really tends to steady running with the large series arc dynamos. It is not theoretically perfect but practically it is good enough.

As a contrast to the satisfactory results obtained with "weatherproof" main line, there are in this country several stations where circuits have been installed to conform with theoretical requirements *as taught in the schools*. I know personally several underground systems which test excellently but break down whenever there is any unusual surge, such as will occur in service in spite of all customary care. The American practice of using series dynamos of high voltage for the supply of street arc lights has developed a few machines which are unsteady as well as some others which are remarkably free from that vice; and the combination of a surging machine built for 125 or 150 arcs with cables insulated by $\frac{1}{8}$th inch (or thereabouts) of good rubber has caused much sorrow to engineers responsible for the combination. Even an alternating circuit will surge occasionally in consequence of a local short-circuit, and cables which would pass Board of Trade inspection, puncture after a fashion that is very trying to a man accustomed to overhead lines. The overhead lines do not break down under such conditions.

In reply to your second question, as to whether superintendents are not tempted to let linemen take risks in bad weather, I regret to say that superintendents are much the same all the world over, and that such officers have at times risked their own lives, and other men's lives, to avoid shutting down of circuits, which is not a practice to be commended. Nevertheless, there have been few accidents on main lines under the conditions that you suggest; because main lines seldom get in trouble; because the risk is well known; and because in most cases a makeshift repair can be made in a manner not involving any personal risk. A hand line, usually a cotton sash-cord well soaked with tallow, is part of the equipment of a trouble-man; and an old hand does very neat work, when occasion requires, in the way of lassoing a "crossed" wire and bridling it up out of mischief. In a well regulated station the trouble-man has the right to order any circuit shut down, and is expected to avail himself of this right as often as he thinks advisable. The superintendent who sends men into danger has always been the exception, and I think is disappearing altogether from our ranks. The superintendent who goes in himself, will, I suppose, always remain with us. Some of us are not entirely ashamed of scars got in our younger days in just this way. Our comment is, when the subject is mentioned, that we are now old enough to know better; that it takes a youngster to be so foolish.

You will allow me, as a stranger to your columns, the privilege of explaining that I have been for years an advocate of underground wires, and that the circuits which I have placed underground have been free from breakdowns. And you will appreciate that when I speak of theory as taught in the schools, I mean the incomplete theory which has grown out of practice, and which, therefore, is usually a year or two (at least) behind practice. The theory of the line on which the leakage is uniformly distributed has been studied only by the telegraphists, and their results are only of indirect service to the electric light man. The schools, so far, condemn low total insulation on any circuit, and are just beginning to understand that a leaky circuit which will not break down has been for years the accepted standard of American overhead practice. American underground practice was influenced at first by the school theory, and the early failures were due to a belief that high measured insulation was all that was requisite. Within the last five years we have added a breakdown test to our insulation test in writing cable specifications, and some of us now buy cables without any test but a breakdown test. In this we are approximating our underground theory to our overhead practice. We have not any overhead theory; therefore there continue to be inquiries such as yours as to why such circuits as ours are possible. My article, on which you commented, was not so much a defence of our overhead construction as an invitation to some of our scholastic friends to consider the facts, and to evolve from them a theory which would be acceptable to both students and workers.

Alex. Dow.

Detroit, U.S.A.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending April 5th, 1897.	£	s.
Albany	32	0
Alexandria. Teleg. mat.	61	0
Amsterdam	175	0
Antwerp	22	0
Bilbao	32	0
Bombay	13	0
Brisbane	150	0
Brussels	918	0
Buenos Ayres. Teleg. cable	4,495	0
Bunderberg	15	0
Calcutta	691	0
" Teleg. mat. ...	44	0
Cape Town	185	0
Cologne	28	0
Colombo	20	0
" Teleg. mat.	24	0
Copenhagen. " "	23	0
Delagoa Bay	50	0
Durban	165	0
Flushing	14	0
Fremantle. Teleg. mat.	6,318	0
Hong Kong	50	0
Jersey. Teleg. mat. ...	35	0
Malta. Teleg. cable ...	8,280	0
Ostend	25	0
Paris. Teleg. mat. ...	26	0
Pernambuco. Teleg. cable	9,000	0
Port Elizabeth	119	0
Rangoon	10	0
Singapore	156	0
" Teleg. cable	14,109	0
Stockholm	8	0
Sydney	315	0
Wellington	251	0
Yokohama	143	0
Total ...	£46,005	0

Week Ending April 5th, 1898.	£	s.
Adelaide	334	0
Alexandria. Teleph. mat.	16	0
Amsterdam	60	0
Barcelona	41	0
Boulogne	84	0
Bombay	333	0
Calcutta	329	0
Cape Town	139	0
Colombo	51	0
East London	51	0
Flushing	36	0
Genoa	500	0
Gibraltar	199	0
Malaga	196	0
Maderia	40	0
Melbourne	135	0
" Teleg. mat. ...	500	0
Odessa	90	0
Port Elizabeth	670	0
Reval	315	0
Rio Janeiro	63	0
Stockholm. Teleph. mat.	100	0
Sydney	347	0
Trieste. Teleg. mat. ...	400	0
Trinidad.	16	0
Yokohama	225	0
Total ...	£6,870	0

Foreign Goods Transhipped.

	£	s.
Sydney	66	0
Oporto	191	0

The Alexandra Palace.—In our "Note" last week *re* the electrical features of the Alexandra Palace, we omitted to mention that the lighting and motor power work of the Palace and grounds is being carried out by Mr. Percy Huddleston, on behalf of the Acme Motor and Traction Company. It is running at a voltage of 250 volts, and the work is being done according to the Phœnix Fire Insurance rules. The motive power plant employed includes two 10-H.P. nom. Crossley gas engines and a 20-H.P. nom. compound Fowler undertype engine. The dynamos and motors were specially made at the Acme Motor Company's works at Brentford. The arc lamps used are by the British Blahnik Arc Light Company, Limited.

New Offices.—Messrs. Dick's Asbestos Company, of Canning Town, have taken offices at 51 and 52, Fenchurch Street, E.C.

Electrical Wares Exported.

Week Ending April 12th, 1897.	£ s.	Week Ending April 12th, 1898.	£ s.
Alexandria	144 0	Albany	15 0
" Teleg. mat.	99 0	Amsterdam	100 0
Amsterdam	100 0	Antigua. Teleg. mat.	16 0
Antwerp	17 0	Calcutta...	56 0
Auckland	231 0	Cape Town	1,102 0
Bombay...	134 0	Delagoa Bay	16 0
Brisbane. Teleg. mat...	738 0	Durban	211 0
Buenos Ayres	77 0	Gothenburg	22 0
Casino. Teleg. mat. ...	26 0	Hong Kong	812 0
Calcutta	50 0	La Plata	12 0
Cape Town	538 0	Lisbon	75 0
" Teleg. mat...	3,536 0	North Atlantic. Teleg. cable... ...	11,520 0
Colombo...	12 0	Port Elizabeth	258 0
Delagoa Bay. Teleg. mat.	5,837 0	Sydney	653 0
Durban	261 0	Wellington	100 0
East London	174 0		
Flushing	92 0		
Gothenburg	19 0		
Hamburg. Teleg. mat.	158 0		
Madeira...	25 0		
Madras	45 0		
Malta	90 0		
Marseilles. Elec. launch	225 0		
Melbourne	99 0		
Ostend	76 0		
Paris	380 0		
Port Elizabeth	558 0		
" Teleg. mat.	155 0		
Quilimane. Teleg. mat.	482 0		
Reval	113 0		
Rockhampton	350 0		
Santos	202 0		
Shanghai	189 0		
" Teleg. mat....	820 0		
Singapore	54 0		
Stockholm. Teleg. mat.	55 0		
Suez. Teleg. mat. ...	190 0		
Vigo. " ...	26 0		
Wellington	48 0		
Yokohama	200 0		
Total	£16,612 0	Total	£14,958 0

Books Received.—"Alternate Currents in Practice," translated from the French of Loppé and Bouquet by F. J. Moffett, B.A. Whittaker & Co., 15s.

"Theory and Practice of Electrolytic Methods of Analysis," by Dr. Bernard Neumann, of Aachen, translated by J. B. C. Kershaw, F.I.C. Whittaker & Co., 10s. 6d.

"Radiography and the X Rays: In Practice and Theory," by S. R. Bottone. Whittaker & Co., 3s.

Catalogues.—We have received from Messrs. Gent and Company, of Leicester, a copy of their price list of pneumatic and electric bells, telephones, batteries, wires, &c., in which are given numerous illustrations of these classes of apparatus and sundry accessorial parts. From the same firm we have also received a pamphlet on electric lighting, giving general instructions for both town and private plants. The machinery and apparatus, and the many small fittings necessary for a lighting installation are illustrated and described in the pamphlet. Both lists contain prices.

Messrs. Dobson & Curtis Bros., Limited, of Suffolk Street, Dublin, send us a copy of the third edition of their catalogue of electric bells, telephones, &c. This firm, which has also a Birmingham branch, has carried out many large contracts in both England and Ireland, the most recent in England being for the Cycle Components Manufacturing Company, of Birmingham, the Dunlop Pneumatic Tyre Company, of Coventry, and Mr. Harvey Du Cros's private residence at Cornbury Park, Oxfordshire.

The Corporation of London v. City of London Electric Lighting Company.—At the Guildhall last week, before Alderman Sir J. T. Ritchie, an application was made concerning the City of London Electric Lighting Company, Limited, by the City Solicitor on behalf of the Corporation to ascertain the fees and reasonable expenses of an electrical inspector employed by the City, who claimed to the amount of £1,142 2s. 7d. under Section 47 of the Electric Lighting Orders Confirmation Act, 1890. Mr. Rose-Innes represented the Corporation of the City of London, and Mr. Roskill appeared for the company.

Mr. Rose-Innes opened the case, and pointed out that so far as the public was concerned it was essential that the electric light supplied should be kept up to a certain standard. The Electric Lighting Order of 1892 provided that an electrical inspector should be created by the Local Authority—in the present case the Corporation—and that all fees and reasonable expenses, unless agreed upon, should be ascertained by a court of summary jurisdiction, or, where appointed, the Board of Trade. What the Alderman had to decide was the amount to be paid by the electric light company to the Corporation for the inspection of meters. The electric inspector was to be "an impartial person standing in a judicial position," and the point which arose for determination was—apart from the salary which the Corporation saw fit to allow this gentleman—what were the fees and reasonable expenses in regard to the work which he had done.

Mr. Roskill said he did not dispute the scale of fees settled by the Board of Trade.

Mr. A. A. Voysey, electrical engineer to the Corporation, said in respect of his employment as electrical inspector, he received a salary from the Corporation. He was familiar with Sections 35 to 47, showing his duties. He found it necessary to have a testing office; this was near the Wool Exchange. The rent was originally £195 a year, but it was afterwards reduced to £170. This was paid by the late Commissioners of Sewers. His duty was to test meters with a view of deciding disputes between the lighting company and the consumer. The witness gave the various items of office expenses, which he said were paid by the Corporation. Mr. Voysey said he was aware that other public bodies had electrical inspectors—the London County Council, for instance.

Mr. Roskill: Are you aware that they never test meters, except on the premises of the consumer?

The Witness: Certainly not.

Mr. Roskill: Then you would be surprised to hear that that is so?

The Witness: Yes. I should not believe it.

Sir James Ritchie: In my neighbourhood the County Council have a beautiful building, and outside is written "County Council Testing Station."

Mr. Roskill said he was now informed that the County Council did have their own testing stations, but they made no charge on what was technically called the "undertaker."

Mr. Voysey, in answer to further questions, said he did other work besides testing in his office.

Mr. Roskill then at some length argued on the construction of the words "reasonable expenses." He contended that such expenses meant those incurred by the inspector travelling to test meters, and so forth, but how the Corporation could contend that the company were liable for any portion of the items put forward passed his understanding. The contention of Mr. Rose-Innes was this: That the Corporation appointed an inspector, supplied him with offices, instruments, and assistants at any cost they pleased, and then charged the electric lighting company for these things.

The Alderman: I have come to the conclusion that these are not reasonable expenses within the meaning of the Act, but I suppose one will have to hear evidence of what may be reasonable. I do not think that the electrical company are bound to provide offices and so on for these inspectors.

Mr. F. Bailey, chief engineer to the City of London Electric Lighting Company, having given evidence,

Sir James Ritchie said if a higher Court held that the items mentioned could be included amongst "reasonable expenses," in order to save the parties coming before him again, he would fix an amount. Inasmuch as the inspector had said that he gave about two-thirds of his time to testing he would reduce the amount to £937 1s. 8d. This was merely a formal matter to save the case being brought before him again to settle this question should a higher Court decide against him.

Mr. Roskill: Then the summons is dismissed subject to a special case.

Dissolution of Partnership.—Messrs. H. W. Ellis and E. W. T. Ward (Ellis & Ward, electrical engineers, Edmund Street, Birmingham) have dissolved partnership. Mr. Ellis will continue the business at the old address under the same name as formerly.

Electric Clocks.—The Swansea Public Library has deferred the question of electric clocks for the library for six months.

Electric Winding Plant.—On February 7th an electrical winding plant was inaugurated at the No. 2 south Great Eastern mine in the presence of an influential company from Gympie and Brisbane. The plant was manufactured and erected by Messrs. Trackson Bros., of Brisbane. A generator made by Laurence Scott & Co., supplies current to the motor, the shaft of which is coupled to the worm gear, which operates a gun-metal worm wheel keyed upon the shaft, which carries the winding drums. The distance between the generator in the engine room and the winding plant below is close upon 2,000 feet. The directors and manager expressed themselves perfectly satisfied at the way the plant handled various loads at different speeds. The design and erection of the plant has been supervised by Mr. P. Trackson, A.I.E.E.

First Meeting.—The first meeting of creditors in the bankruptcy of J. Fletcher and J. A. Hirst (Fletcher, Hirst & Co., electrical and mechanical engineers, of Chester and Derby) is to be held at the official receiver's office, Byrom Street, Manchester, on April 19th, at 3.30 o'clock. The public examination is fixed for April 29th, at 11 o'clock, in the Court House, Burnley.

Liquidation Notices.—At meetings of the British Electrozone Corporation, on February 8th and March 8th, resolutions were passed winding up voluntarily, and appointing Mr. A. E. Edwards, of Broad Street Avenue, E.C., liquidator.

A meeting of Messrs. J. C. Howell, Limited, is to be held at 6, Old Jewry, E.C., on May 16th, at 11 o'clock, to receive an account of the winding up operations from the liquidator, Mr. S. F. Isitt.

Parliamentary Bills.—The *Daily Chronicle* had an article on Wednesday giving particulars of the progress of the numerous private Bills which are now before Parliament. There is an increase in the number and value of the Bills deposited for the session. There are 30 Bills relating to tramways, and the proposed capital involved in them is upwards of £1,800,000. Gas Bills ask £4,732,000, and electricity Bills come in with a modest million, and measures under the provisional order system account for a further sum of three millions odd, which the promoters seek to raise in

respect of schemes for tramway, gas and water, electric lighting, &c. Five Bills to authorise the construction of new underground railways in the metropolis were deposited. The Charing Cross, Euston, and Hampstead Railway Bill has been read a third time in the Commons; another—the City and Brixton Bill has been reported by the Committee which considered it, and awaits third reading, and the Great Northern and City Railway, which is for an extension of the authorised undertaking, awaits second reading. Power to work by electricity is also being sought in the Metropolitan Railway Bill, and has been granted by the House of Commons Committee, to which the measure was referred. Notwithstanding the facilities given to promoters by the Light Railways Act, there are but three measures containing schemes for light railways and one for the acquisition of a railway which it is proposed to work as a light railway. Upwards of 80 provisional orders have been made by the Board of Trade under the Electric Lighting Acts, with a view to their submission to Parliament for confirmation; and there are besides four Bills relating to the supply of electrical energy seeking powers beyond the scope of the general Electric Lighting Acts. Some of the important questions so raised stand referred to the consideration of a Joint Committee of both Houses, which will sit again after Easter, and whose report will be awaited with interest.

Tasker & Sons, Limited, v. London & County Hotels Company, Limited.—This case came before the Coventry County Court on Tuesday last week. The plaintiffs, electric light engineers, of Andover, Coventry, and other places, sued the defendants for goods and work done in the construction of electric light apparatus at the King's Head Hotel, Coventry. It appeared that the plaintiffs supplied the hotel in May, 1897, with an installation of four electric arc lamps, using the city current. Defendants found the humming noise of the lamps annoyed their customers to such an extent that the lamps could not be used, and plaintiffs were asked to remove them. Mr. J. W. Manley, plaintiffs' local manager, stated that this humming noise was caused solely by the fact that the city current was an alternating one. His firm had on one or two occasions made alterations suggested by defendants' manager, with a view to mitigating the noise caused by two of the lamps being hung under a glass roof. The defendant company's case was that their manager was advised by an engineer of the plaintiff company to instal arc lamps, when nothing was said about the noise. They did not allege defective construction of the arc lamps, but the noise caused by them caused the customers to leave the hotel. His Honour gave judgment for £59 8s. 9d. for plaintiffs, striking out some extras for the fitting of speaking tubes which formed part of the claim.

Siemens & Halske.—Messrs. Siemens & Halske, of Berlin, are increasing their capital to £2,000,000. The Austrian and Hungarian branches of this firm are, it is reported, to be formed into a separate joint stock company.

Volenite.—Lord Lurgan, the chairman of the Fish Oil and Guano Company, had a good deal to say to his shareholders on the 5th inst. about volenite, to exploit which his company is bringing out another company. He said that tests of volenite had proved it equal to gutta-percha and superior to vulcanite. Its electrical resistance was really extraordinary. They were anticipating the results of some tests for the possibility of covering cables with this material, but a test of 10 to 12 months would be necessary, and they had seriously considered whether to wait that time before producing it, or whether they would find out to what other uses and purposes volenite might be applied. They decided to make the latter tests at once, and they very soon discovered that volenite was just as valuable for the purpose of steam boiler and steam engine packing as it was for electric cable work. Therefore, in view of its use for various purposes, they decided that they were justified in issuing volenite at once. It was now almost ready for registration. The prospectus was prepared. His lordship read reports made upon the material by Mr. Philip C. Pope, consulting electrical engineer, and Mr. J. W. Bevan, and opinions of other gentlemen. With regard to the manufacture of volenite it is intended to at present confine it to the United Kingdom. Favourable offers had been made for the sale of the patent for America, but it had not yet been decided whether to increase the capital and make it for all the world, or to sell the patent for different countries.

ELECTRIC LIGHTING NOTES.

Ayr.—Mr. Fuller's report as to extensions has been adopted by the Commissioners at a cost of £1,187.

Balmoral.—The daily papers say that the Queen has decided to light Balmoral Castle by electricity, and an enormous quantity of large iron pipes has already been delivered. These pipes are intended to convey water power from the Gelder, a stream running into the Dee at a point about 1½ miles from Balmoral, and the dynamos will be driven by water power.

Barnsley.—The Park and Lighting Committee report having held three meetings for the consideration of Mr. Miller's scheme for electrical supply to the borough. Mr. Miller attended and explained the scheme, and the further consideration stands adjourned until a special meeting on the 23rd inst.

Bath.—Mr. Hammond is to prepare a statement for the Council, showing the amount expended upon the electricity works together with the outstanding liabilities on the balances of contracts, and a special meeting is to be held to consider it. The Electric Construction Company has consented to give a guarantee in connection with the erection of arc lamps without having a preliminary test. Thirty out of 40 new lamps have been erected, and will be connected as soon as the circuit is completed.

Belfast.—The statement of accounts for the year ended December 31st, 1897, showed the electricity undertaking to be in a sound financial condition and progressing rapidly in the public estimation, and in view of the probability of having a considerable sum to pay this year by way of interest on the large capital expenditure connected with the new station which cannot be productive for some time, the balance carried forward from last year was ordered to be allocated for this purpose. The meters necessary on the introduction of Wright's system of charging for electric current on July 1st, are to be purchased, and also a fourth Lancashire boiler to complete the first section of the new station.

Blackpool.—The Corporation passed the following resolutions on 5th inst.:—"That subject to the confirmation of the Local Government Board to the requisite loan, the tenders of the firms undermentioned for extensions at the Corporation Electricity Works be accepted, viz.: Boiler and superheaters, Messrs. Babcock and Wilcox, Limited; condensers and storage tanks, Messrs. Cole Marchent & Morley; rectifiers, Messrs. S. Z. de Ferranti, Limited; boosters, Mr. Chas. J. Cowan; cables, British Insulated Wire Company; transformers, Messrs. Nalder & Hilton, Limited." "That the approved standard clauses issued by the Electrical Engineering Plant Manufacturers' Association, and the Municipal Electric Association, for the adoption among the general conditions of specifications for electrical engineering plant, be referred to the town clerk and borough electrical engineer for inclusion, if they think so fit, in any conditions of specification for electrical engineering plant issued by the Electric Lighting Committee."

Bournemouth.—The following tenders were sent in for supplying and fixing cables, conductors, lamps, columns, fittings, &c., for the lighting of the pier and Lower Pleasure Grounds:—

	£	s.	d.
Messrs. Johnson & Phillips	2,255	18	0
Brush Electric Engineering Company	1,740	0	0
Messrs. Fippard & Cooper	1,521	18	0
Mr. L. G. Tate	1,502	0	0
Messrs. Laing, Wharton & Down, Limited	1,707	0	0
Messrs Cash, Robinson & Co.	1,252	17	0
Bournemouth and District Electric Supply Company	1,415	0	0
British Insulated Wire Company, Limited	1,583	14	9
Mr. E. G. Bryant	1,458	6	0
Messrs. Crompton & Co., Limited	5,204	0	0

The surveyor recommended the tenders of Messrs. Cash, Robinson and Co., and the Bournemouth and District Electric Supply Company for consideration. The Council had a discussion as to whether, seeing that the Corporation license from the Board of Trade for electric lighting purposes had only three years to run, it would be wise to lay down plant and spend £2,000 if the plant would be of no use at the end of that period.

On Thursday last week a Local Government Board inquiry was held *re* several sums to be raised for public works by the Corporation, including £2,500 for the electric lighting of the pier and pleasure gardens.

Bradford.—The Gas and Electricity Committee have decided to reduce the price of electricity for lighting by a ½d. per unit, and have also fixed a sliding scale for motors, making prices range from 2½d. to 1d. per unit.

Brighton.—The Town Council on Thursday last week had a debate upon a proposal by the Lighting Committee to reduce the price of the electric current after the first hour's usage from 1½d. to 1d. per unit. The accounts for the year ended December, 1897, showed that, after making provision for the annual charges for interest and the repayment of loans, there remained a net profit on the year's working of £2,864. Out of this amount the Committee proposed to apply £2,000 to the relief of the rates and to add the £864 to the reserve fund. The Council divided on an amendment by Mr. Buckwell that the price should not be reduced, and this amendment was carried by 18 votes to 17.

Bulawayo.—At a recent meeting of the Municipal Council a letter was read from Colonel Heyman, stating the terms upon which the contractor (being the Electric Light Company), was prepared to supply the light to the Council. This was stated to be 1s. 7d. per unit. It was further stated that the Government was prepared to vest its lighting contract in the Council. This matter was referred to the P. W. Committee.

Camberwell.—The General Purposes Committee has had under further consideration the question of the proposed purchase of the undertaking of the County of London and Brush Provincial Electric Lighting Company, Limited, and has received a statement that the estimated cost of the work done in the parish up to date was £3,200. The committee recommended that the proposed purchase be not proceeded with, and this has been agreed to.

Cardiff.—The Lighting and Electrical Committee has agreed that the conditionally accepted tender of the Atlas Engineering Company, Canton, for the supply of a number of junction boxes for the electrical department be rejected, as the company does not comply with the fair wages clause. The contract has been given to Mr. Wilkinson, of Cardiff.

Dewsbury.—The Electricity Committee has approved of the doubling of the existing trunk mains at a cost of £5,000, of an extension of mains in a part of the borough not yet served at a cost of £2,500, and of the purchase and laying down of an additional engine and dynamo at a further charge of £2,450, including the cost of an extension of the building at the central station. The electrician (Mr. Mitchell) having resigned, to take a situation at Southend-on-Sea, it was decided to postpone the carrying out of the extension scheme until the appointment of his successor. The General Purposes Committee has considered a recommendation that the new electrical engineer should be paid a salary of £200, and be allowed to take a pupil, but has decided to pay £250, and not to allow a pupil to be engaged.

Douglas.—Prof. Fleming was yesterday to have an interview with the Douglas Town Council for the purpose of advising them as to the electric lighting of Douglas.

Dublin.—At the last Corporation meeting the Lord Mayor moved the adoption of a report of the committee of the whole house recommending the application of the Corporation to the Local Government Board for a loan of £20,000 for new electric cables and works connected therewith, and for the establishment of sub-transformer stations. A proposal from the Dublin United Tramway Company to take over the lighting of the city on certain conditions, and an offer of a similar nature from Messrs. Jameson, Cobb, Pearson and Co., of London, were considered simultaneously with the report, and his lordship moved that they be taken as read. The report stated the committee considered a report from Prof. Kennedy, consulting electrical engineer, and finally decided on his advice to adopt cables insulated with vulcanised bitumen as made by Messrs. Callender & Co., and of a system of low-tension distribution.

Durham.—The Town Council is considering the question of electric lighting. The Gas Lighting Committee recommended that specifications and estimates be obtained of the cost of erecting plant, but an amendment referring the matter back to the Committee to obtain terms upon which electric lighting companies would supply the Council for street lighting and private consumers was adopted.

Dundee.—Mr. Tittensor, the electrical engineer, submitted a lengthy report to the Gas Committee last week with reference to the extension of the electric lighting area of the city. He gives a statement of the development of the lighting within the old area since the opening of the supply in 1893 as follows:—

	Lamps connected.	Units sold.	Increase.
1893	8,470	66,228	—
1894	11,860	156,843	90,615
1895	14,001	202,437	45,594
1896	17,945	254,278	51,841
1897	22,897	323,187	68,909

The length of streets through which mains were laid for supply up to the end of 1897 was four miles. The extended area gives a total length of street of eight miles. In the new districts he anticipated a demand for 25,000 lamps after five years, exclusive of public lighting. The distribution mains of the new area would be fed from the present generating stations through four sets of feeder mains. The whole of the extended area could be supplied from the present station, and the following additions would be required:—The present engine and boiler house would have to be extended. The additional plant required would be:—Boilers equal to 900 horse-power, engines and dynamos equal to 900 horse-power, together with the necessary steam pipes, pumps, economiser, and switching gear. He estimated the cost of all these extensions as follows:—Distribution mains, £14,400; feeder mains, £4,000; buildings, &c., £3,600; boilers, seatings, and fittings, &c., £1,800; engines, dynamos, &c., £8,000; steam pipes, &c., £1,200; switchboards and instruments, £1,400; economisers, &c., £600—total cost, £35,000. This included spare culverts along the existing tramway routes for the reception of feeder mains in the event of electrical traction being adopted, as recommended by Messrs. Urquhart & Small. The most suitable system to adopt for the extended area would be a three-wire system distributing at 200 volts at consumers' terminals. This would enable the whole of the plant and batteries now in use at the generating station to be used in conjunction with the new plant without much alteration, and would also make the new system of mains gradually take up the increasing load on the old area, which would thus develop itself into a three-wire system at 200 volts similar to the extended area. He did not consider that a higher pressure of supply than 200 volts was necessary within the limits of the extended area, as the higher the pressure adopted, the greater the disadvantage to those customers using arc lamps, in the increased cost of current for the same. At the present time there were 22,897 lamps connected in the old area, of which 16,000 were supplied at the old pressure of 100 volts, the remaining 6,897 being supplied at 200 volts, in accordance with the statutory notice given in June, 1897. It would be of great advantage if the whole were converted into a 200-volt supply, although it would entail serious disadvantages to several of the customers. If a compulsory change were made all over the city, the expense would devolve upon the Town Council, which would include replacing all 100-volt lamps with those at 200. It would also be necessary to exchange all arc lamps burning in pairs at 100 volts for those designed to burn in pairs at 200 volts, and all motors in use at 100 volts would have to be rewound. The total cost of this would be about £1,800. The most serious objection to such a sweeping reform was that those customers (of which there were several) having at present only one arc lamp installed, would be paying at the rate of 9d. per unit for current for the same lamp at 200 volts, being just double their original rate. No doubt this objection would be overcome at no distant date by the introduction of new and improved lamps. He would therefore recommend that all those mains supplying customers at 200 volts be connected up to the new system to be laid as a three-wire system at 200 volts, and those mains supplying the older customers at 100 volts be "inter" connected as a modified five-wire system supplying at 100 volts, until such time that it might become necessary or expedient to gradually change on to the 200-volt supply, after which the whole of the old and new area would resolve itself into one three-wire system at the higher voltage. He recommended that the laying of the mains should be proceeded with gradually as the demand arose, thus spreading the cost over several years. The present requirements would be the extension of the present buildings at the generating station, the laying down of the three-feeder mains to the north, east, and west districts, and the erection of one boiler, engine, and dynamo, with the necessary piping, &c., at a cost of £9,300. The committee resolved to consider the whole question at another meeting.

The Gas Committee recommends that Mr. Tittensor's salary be advanced £50 per annum.

East Grinstead.—There was a long discussion at the District Council last week on the proposition made by Mr. Steer that application be made for a provisional order as soon as the probable cost to be incurred in carrying out a scheme is ascertained. The resolution was carried.

Eccles.—The electrical engineer (Mr. Clirehugh) has reported upon the progress of the electricity works. The buildings had progressed very slowly. The main laying will be commenced during this week. The cables are now all manufactured. Mr. Clirehugh's draft of charges to be made for electrical energy has been approved.

Edinburgh.—The Cleaning Committee recommended the Council to light a number of additional streets by electricity, but after discussion the matter was re-committed. Mr. Mackenzie, in supporting the Committee's proposal, said that the number of lamps sanctioned formerly by the Council, including 37 for Portobello, was 540. The Council sanctioned 91 additional, which included 12 for the Middle Meadow Walk, which had since been withdrawn at the request of the Parks Committee, who considered that the Middle Meadow Walk was not suitable for the electric light. If these 59 new lamps were sanctioned the Electric Light Committee saw its way to reduce the cost per lamp all over the city from £16 to £14. The Electric Lighting Committee recommended that the charge for electric energy as from May 15th next be 3½d. per unit with discount, the charge for each public lamp £14 per annum, and the charge for motor power 1½d. per unit. On the motion of Bailie Mackenzie, the first part of the motion was agreed to, and the second portion was re-committed, in view of the discussion that had taken place on the report of the Cleaning and Lighting Committee.

Folkestone.—At the West Cliff Hotel electricity has been installed throughout. In all there are 640 lights.

Halifax.—The Gas Works Committee entertained the members of the Town Council at a banquet recently, and in some remarks made by Mr. Wilmshurst, the borough electrical engineer, it was stated that the fact that the Electricity Committee had provided for many years extension undoubtedly militated against their making an immediate profit, but he thought there was a prospect of turning the corner this year. The prospects for the future were very good. On March 31st, 1895, they had 92 consumers; a year later they had 179; on March 31st, 1897, they had 235, and for the year ending March 31st, 1898, 309. So that although they had not made a profit, yet they were building up a very sound business.

Hastings.—The Electric Light Company is to light the front during April and May at £4 per lamp per month, and during June and July at £3 per month.

Hereford.—The Electric Lighting Provisional Order has been referred to a special committee for consideration and report.

Ilfracombe.—The District Council proposes to expend £10,000 in the construction of electric plant, &c., for the purpose of illuminating the town by the electric light.

Inverness.—The Town Council has been discussing the feasibility of introducing the electric light into the town. Messrs. Fraser & MacCallum, solicitors, had written to the effect that a local company was about to be formed with the view of lighting the borough and vicinity by electricity, and asking if the Council would agree not to oppose the undertaking. It was considered by the Council that the works should be done by the municipality, and a committee is to be appointed to ascertain whether there is such a demand for the light as to justify the Council in taking steps to introduce it.

Lancaster.—Mains are to be laid for supplying current to the Bowerham Board School. The Lighting Committee recommends the Council: "That the Electricity Committee be asked to discontinue the charging of rent for the street arc lamps, in order to place a larger sum of money at the disposal of this Committee for street lighting purposes." The consideration of the matter is to be deferred for six months.

Leith.—The Town Council has resolved: "That, owing to the great cost of carrying out the electric lighting scheme, and the probability that, for a number of years at least, it will be a serious burden upon the ratepayers, the Electric Lighting Committee be instructed to use the utmost economy, consistent with efficiency, in carrying out the work, and that no new expenditure be incurred

beyond that already sanctioned without first reporting and obtaining the authority of the Town Council." The chairman remarked that the estimates had already been cut down by £3,000.

Lewes.—A special meeting of the Council is to be held to consider what steps shall be taken regarding the electric lighting provisional order when it has been confirmed by Parliament.

Liverpool.—The City Council has resolved that from April 1st, 1898, the prices to be charged for the supply of electrical energy at a pressure of 230 volts be:—For general lighting, 5d. per unit for each unit up to 1,000 units per quarter, and 4d. per unit for each unit in excess of 1,000 units; for Corporation departments, 4d. per unit; for street lighting, 3d. per unit; for power purposes, 2d. per unit.

London County Council.—The Council has decided to lend £13,660 to the Vestry of Islington for electric lighting extensions. The Finance Committee stated that the Vestry proposed to add to the Eden Grove generating station two water-tube boilers, one 500-H.P. engine, and one 330-kilowatt alternator, and to extend the mains in Liverpool, Wellington, and St. James's Roads. The Council is withholding its consent from the County of London Company re-laying mains in several Dulwich and Peckham roads for the present, on account of the appointment of the Parliamentary Committee on electrical matters which is shortly to sit. It will be remembered that last February the Council accepted the tender of the National Electric Free Wiring Company to carry out the electric light installation at the chief station of the fire brigade for £992, less the amount of the wages of certain of the Council's employés to be engaged on part of the work. Referring to this matter, the Fire Brigade Committee has now reported that, on further consideration, it has come to the conclusion that it would be better for all the work to be carried out in its entirety by the company's employés. The company had acquiesced in this, and the Council's servants employed on the work had been withdrawn.

Lyndhurst.—Messrs. Warburg, Dymond & Co., of London, have informed the New Forest District Council that it was proposed to form a limited liability company with the object of putting down a plant for the electric lighting of Lyndhurst, and that they purposed purchasing a suitable site at Glasshayes. It was their intention to apply forthwith for a license from the Board of Trade. The Lyndhurst Parish Council is to have the opportunity of considering the matter and taking the opinion of a parish meeting upon it.

Oldbury.—The District Council has withdrawn its opposition to the provisional order of the Midland Corporation, Limited.

Ossett.—The Town Council has received a provisional order authorising the Council to lay down electric lighting plant, and to supply the borough.

Paddington.—The Guardians' Visiting Committee is inquiring into the cost of installing the electric light in the north block of the workhouse, the chapel, and the dining hall.

Rathmines.—At the last meeting of the Commissioners Mr. Booth called attention to a report made about 12 months ago by Mr. Hamwood, electrical engineer, setting out two methods by which the electric lighting of the township might be carried out. Mr. Hamwood was in Dublin in January last, and then promised to draw up an amended report for 25 guineas. In that report several of the previous proposals would be altered, owing to the improvements that had recently taken place in this branch of science. He proposed that the board should accept this offer. It was resolved to request the Electric Lighting Committee to meet and consider what steps the board should take to save their rights under the order in Council, and to take such action as they may deem advisable.

Reading.—The Highways and Lighting Committee has received a letter from the Board of Trade, enclosing an amended description of the systems proposed to be adopted for the supply of energy under the Reading Supply Order, 1893. The committee also received Mr. Bowen's report, and on his recommendation approved the proposed works, subject to a number of amendments and conditions suggested by him.

Salford.—The Council has approved the proposal of the Electric Light Committee to purchase land abutting on Bedlam Lane, off Strawberry Road, as a site for a new generating station for the electric light. The Council were asked to vary the resolution of the Council of January 5th last, authorising an application to the Local Government Board for power to borrow £50,000 for the purposes of electric lighting. It was now, under different circumstances, proposed to ask for £33,000. The resolution was adopted.

Shoreditch.—The cost of laying larger cables in Curtain Road, Great Eastern Street and Old Street (authorised by the Vestry) will be about £2,000.

Southall.—The Town Council has received a letter from Messrs. Brewer & Meaby, with reference to supplying electric light. This has been referred to the Committee.

Southport.—The Gas Committee recently opposed a proposal on the part of the Electricity Committee to add 42 arc lamps to the street lighting, and it was withdrawn. The salary of the electrical engineer (Mr. C. D. Taite) is to be advanced from £230 to £280.

Stirling.—Mr. R. F. Yorke has submitted a lengthy report to the Police Commissioners on the water power available at Touch for the electric lighting of Stirling. He shows that by utilising the water power which exists in connection with the Touch reservoirs, they could, with a moderate expenditure of some £13,000 to £14,000, deal effectually with the lighting of the extended area, viz, 8,000 lamps connected; and that by charging for the private lighting at the rate of 4½d. per unit, there would be a considerable surplus as soon as the total number of lamps have been taken up. His estimate for capital outlay is as follows:—

	£
Two 54-H.P. turbines, with frames, suction pipes, delivery and erection	540
Two dynamos	380
Switchboard	30
Buildings	200
Fittings, &c.	20
Underground cable—3½ miles concentric 37/13, with laying and jointing	2,495
Accumulators—250 cells = capacity 308 amperes, for three hours, or 154 amperes for six hours = 4,466 lamps for three hours	2,525
Stands and converting buildings	100
Allow for continuation of two 12-inch pipes, with laying and jointing	200
Allow for trench for cables	100
Engineer's fees and contingencies	410
	£7,000
Allow for distribution—mains, meters, &c.	6,500
	£13,500
Working expenses	£650

For repayment of generating and distributing plant, with interest, allow 5 per cent. of total cost of £13,500 = £675. Although 8,000 lamps connected is a large proportion for the number of the inhabitants, it will be possible, by utilising the additional power from another reservoir, to supply current for another 4,000 lamps, *i.e.*, a total of 12,000 lamps connected. Mr. Yorke's scheme includes turbines by Messrs. Gilkes, dynamos by Laurence Scott & Co., cables by the British Insulated Wire Company, and accumulators by the Chloride Electrical Storage Syndicate. The Commissioners remitted it to the Lighting Committee to see whether the necessary consents and wayleaves can be obtained, and to report, so that they are not at present committed to anything.

Swansea.—Mr. Manville's report on the electric lighting scheme puts the capital expenditure, after adding 7½ per cent. for contingencies, engineering, &c., at £35,936. In his estimate of the revenue derivable, he gives 15,700 8-C.P. lamps for private lighting, which would, at 4½d. per unit, bring in £4,444, whilst the public lighting would bring in £733, making a total of £5,177.

Wednesbury.—The Town Council last week resolved by eight votes to five, to make application for a provisional order. There was a lengthy discussion.

Woking.—The Electric Supply Company has undertaken to have all the street lamps overhauled immediately and renewed where necessary.

Yarmouth.—The Council has decided to borrow £4,800 more for further additions to the electric lighting plant, making £40,000 in all. In the last three months considerably over £500 has been earned beyond the actual cost of production. Mr. George Bryant, assistant engineer of the electrical supply station, has been appointed chief engineer, in succession to Mr. A. W. Ranken, who had resigned.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Argentine.—At last week's meeting of the Anglo-Argentine Tramway Company, held in London, the Chairman said that with regard to the question of electric traction, the Board had come to the conclusion that favourable results might be obtained by using electricity on certain parts of the line. An offer had been made by a body of financiers to find the necessary capital for the conversion of the system, but he was unable at that moment to enter into details. The shareholders would be consulted before any binding agreement was entered into.

Blackpool.—At last week's Council meeting Mr. J. Brodie, the chairman of the Electric Lighting and Tramways Committee submitted the report of a deputation which had visited Paris, Berlin, Hanover, &c., to study the system of tramway traction. It was the unanimous recommendation of the deputation that the overhead system be adopted. If the Council favoured the accumulators, well and good, but they must be prepared to run the tramways at a loss.

Brighton.—The Council has refused to grant a license to a Montreal firm to construct and operate an electric trolley system in the borough.

Derby-Ashbourne.—The promoters of this proposed light railway have decided to apply to Parliament for further powers, this step having been rendered necessary by the decision recently arrived at to alter the original plans as to the termini.

Dudley.—On Tuesday last week the mayor stated to the Town Council that the previous day Mr. Albright, Mr. Addenbrooke, and Mr. Lowe, of the Midland Electric Power Distribution Company, had attended a meeting of the Electrical Railway and Tramway Committee and quoted prices for local supply of electricity. The company would supply electricity and lay mains for the first 100 hours at 5½d. per unit, and at 2½d. per unit for subsequent supply. If the Corporation provided the mains the prices would be 5d. and 2d. The company would supply the electricity in bulk at a uniform price of 3¼d, they laying the mains; or 2⅝d. if the Corporation laid the mains. The price for public lighting would be 1·6d. per unit, and for electric traction 1¼d. per unit. It was understood that the current would only be brought to a given point in the town. Subsequently Alderman Garratt and Alderman Bagott were added to the Committee, and Alderman Bagott made a hopeful statement as to the future of the tramway undertaking. He was, he said, sure that with good management the proposed electric tramways would be a source of great profit to the borough. The Council confirmed formally the recommendations to take the necessary steps for taking over the lines.

Dudley and Stourbridge.—The British Electric Traction Company, which recently purchased the Dudley and Stourbridge Tramways for £44,000, has entered into a contract for the transposal of the existing steam tramway from Stourbridge to Hart's Hill, Dudley, into an electric system. A site for a power station has been secured by the company near Canal Street, Brierley Hill, and electric cars will be run from Hart's Hill to Stourbridge within about six months, and through Dudley as soon as, and if, arrangements can be effected with the Dudley Corporation. The contract for the alterations to the permanent way and for the electric equipment has been secured by Messrs. Dick, Kerr & Co. It may be remembered that the British Electric Traction Company, after acquiring the line from Stourbridge to Hart's Hill, obtained an order to construct a new tramway to Cradley Heath from Dudley, and to Kingswinford and Stourbridge. The Dudley Town Council, however, are opposing the Dudley and Cradley Heath order given by the Light Railway Commissioners on the ground that they are desirous of making the line themselves. The lease of the portion of the Dudley and Stourbridge line from Dudley to the boundary at Hart's Hill expires at the end of about five years, and it is the intention of the Dudley Corporation, as the matter stands at present, to seek to work that portion also.

Folkestone.—The promoters of the Folkestone District Light Railways have intimated their intention of not proceeding with the application to the Commissioners for the construction of the proposed railways in Folkestone, Sandgate and Hythe.

Liverpool.—At the last City Council meeting, Sir Arthur Forwood, chairman of the Tramways Committee, moved a recommendation that the necessary steps be taken to construct a new road continuing Park Road into Aigburth Road. They were laying down a new system of electric tramways to the Dingle. At present the lines running from Peel Street, Park Road, to the Dingle dipped 15 feet, and from the Dingle to Aigburth Road they rose again 12 feet. The suggestion of the committee was to acquire the property between the corner of Peel Street and Aigburth Road voluntarily, so that they might then make a direct connection between Aigburth Road and Park Road almost on a dead level at a reasonable cost. After discussion the proposal was taken back.

Llandudno.—The Town Council last week agreed to a scheme promoted by a syndicate for the construction of a light railway connecting Colwyn Bay, Llandudno, and Deganwy.

Newcastle.—At a meeting of the Tramways Committee on 4th inst., Mr. Laws, city engineer, reported that the total amount of double track upon the seven sections already decided on by the committee amounted to 12 miles 394 yards. He estimated that the cost of laying down this distance, either with cables or the overhead electrical system, would be £245,000. It was agreed, acting under a resolution passed by the Council, that Mr. Laws should be requested to furnish the committee with the names of two experts—one to advise the committee with respect to the cable, and the other with respect to the overhead electrical system. Mr. Laws will present the names of the experts whom he deems most suitable for this work to the next meeting of the committee, to be held on May 3rd. The resolution provides that the committee "shall have the power to engage an expert or experts to advise with respect to the best system to be adopted, such experts to be gentlemen who are not connected financially with any system of tramways, or any company for the promotion of tramways."

Northampton.—In our note regarding the Northampton tramways last week, the word Nottingham in line 3, should, of course, read Northampton.

Norwich.—Notice appeared in the *London Gazette* last Friday of application being made by the Norwich Electric Tramways Company for additional provision for leave to introduce in their Bill various new powers for street widening and alteration, and for deviation of the authorised tramway.

Nottingham.—The report of the Committee recommending electric traction, which we briefly referred to last week, came before the Town Council on 4th inst., and after lengthy consideration had been given to the matter the following resolution was unanimously passed:—"That the report of the Tramways Committee now presented to the Council be received and adopted as and for the first reading, and that the second reading thereof be taken at the quarterly meeting of the Council in May next; that in the meantime the Tramways Committee be authorised to instruct the city engineer to proceed with the necessary surveys, plans, and sections which will be required for the purpose of enabling the Council to give notices and take all proper steps to promote a Bill during the next session of Parliament for carrying out the recommendations of the Tramways Committee now laid before the Council if that course be ultimately adopted."

Salford.—A sub-committee has been appointed by the Highways Committee of the Town Council to report upon the probable cost of taking over and working the tramways, and also the cost of electric traction. It has been reported to the Highways Committee, on the authority of Mr. Alderman Milling, that it is not the intention of the Manchester Corporation to engage an expert to advise them, but they will reply upon the advice of their own electrical engineer in any matters relating to the future working of the tramways of the city. Further that Dr. Hopkinson has been engaged by the Manchester Corporation to give evidence on their behalf before the Parliamentary Committee against the Manchester Carriage and Tramways Company's Bill.

St. Helen's.—The Electric Lighting and Traction Committee of the St. Helen's Corporation has definitely resolved that electricity on the overhead system be adopted and introduced as the motive power on the Corporation tramways, and that accordingly the town clerk be instructed to apply to the Board of Trade for their consent to the use of electricity for the trams, and also for their sanction to borrow £25,000, the estimated cost of the generating works and plant, and the distributing plant necessary for this purpose.

Stretford.—The District Council has decided to give notice to the Manchester Carriage Company that in July next, directly the statutory term of 21 years expires, it will promote a Bill in Parliament empowering the Council to work the tramways by mechanical power, including electrical haulage, and to borrow funds to defray the cost thereof.

Waterford.—The Corporation after an interview with Mr. Palmer in reference to his application for an electric tramway concession, has granted same on the following terms:—That a lease be granted for 75 years at a nominal rent for the first 10 years, and that subsequently a rent amounting to 5 per cent. on the amount of the dividend paid the shareholders be reserved to the Corporation. That the concession be from the Terminus of the Waterford, Dungarvan and Lismore Railway to the Bridge, along the Quays, the Mall, Parnell Street, portion of the Manor, Lombard Street, William Street, and up Newtown as far as the Municipal Boundary. The Corporation to reserve to themselves the right to seek for Parliamentary powers to purchase the tramway after the expiration of 50 years. All plans and specifications to be subject to the approval of the Council. Matters of detail to be subsequently arranged.

TELEGRAPH AND TELEPHONE NOTES.

Bristol.—The report of the Bristol Chamber of Commerce which will be presented to the annual meeting next week traces the rapid growth of the telephone in the West of England and South Wales. In 1893 there were 4,470 lines in this division, and there were now nearly 9,000, and the rate of increase was still growing. In Bristol, after considerable delay, the underground system was now being actively carried out, in Bath the work was approaching completion, and in several other towns in the district arrangements were in progress for substituting underground cables for poles and wires. Tenders for a large new building in a central position in Bristol were now under consideration by the London Board; there would be a very spacious switch room, and a large switchboard with all the latest improvements for ensuring correctness and rapidity in the transmission of messages. Unexpected delays had arisen in opening exchanges at the group of Wiltshire towns, but the Post Office was now constructing the connecting trunk between Bradford and Bath, and in a few weeks several of these towns would have exchanges opened in them and others would soon follow. The group included Bradford, Trowbridge, Melksham, Devizes, and Warminster in Wilts, and Frome in Somerset. An exchange had been opened at Pershore in connection with Evesham and Worcester. Hereford, after many difficulties and delays, had been opened, and Chippenham, Cirencester, and Dursley would soon follow. Efforts were being made to introduce the telephone at Wells, Glastonbury, Street, Cheddar, and Axbridge in Somerset. In Cornwall the use of the telephone was rapidly extending. Last year Falmouth and Pensance were the only exchanges in the county, now Truro, St. Austell, Fowey, and Par had been opened. And Newky and other towns were likely soon to be added to the list. In Devonshire exchanges had been opened at Barnstaple and Bridleigh, Salterton, and it was hoped that Bideford [and neighbouring places would soon follow.

Delays in Australian Telegrams.—Although no official notifications have been received from Berne, still we can gather from the Australian newspapers recently to hand that the Australian trunk landlines continue to be periodically interrupted. On February 26th we read, that European cable messages were subject to delay on the Port Darwin line. On March 1st the "telegraphic communication on the Port Darwin line which had been temporarily interrupted was again restored." Under date of March 7th we read that the Roebuck Bay landline had been interrupted for two days.

It will be remembered that the Roebuck Bay line is supposed to afford an alternative to the Port Darwin line; which latter on March 8th was interrupted near Port Darwin, and the cable traffic had to be diverted *vid* the Roebuck Bay landline, then presumably convalescent. It is painful to find that as concerns this latter line, the Postmaster-General of South Australia expresses himself in ungrateful terms. He says it "is acknowledged to be the worst line in Australia, the many fogs on the coast rendering it very hard to get signals through." This may, however, only be the expression of friendly rivalry, as judging from the reports concerning the Port Darwin landline, for which he is responsible, it is difficult to say which is the worst of the two lines. On February 14th, Sir Charles Todd, in referring to the delay in the transmission of cable messages to England, is reported to have said: "the interruptions caused by the crossing of creeks and rivers have been very few. In fact, I can only remember four arising from that cause." It would be interesting to know the causes of the numerous other interruptions and delays on this line, which this gentleman appears to ignore, as we find that for the six months before the date on which Sir Charles Todd is reported as above, there were no fewer than 18 days on which the Port Darwin line was either totally interrupted, or on which messages on that line were greatly delayed. There may possibly be other interruptions and delays of which we are not informed, but this is only due to the fact that the authorities in Australia appear to neglect the rule of the International Telegraph Convention, of which they are signatories, by omitting to advise the Bureau International at Berne of such occurrences. On examination we find that since the beginning of September last there have been 24 days on which interruptions or serious delays have occurred on the Port Darwin line, and 17 days of interruptions or serious delays on the Roebuck Bay line; these interruptions sometimes occurring simultaneously, and the total of 41 days is probably much below the actual record of default. We observe that the public in Australia are at length making serious protest against the present inefficient system.

Dudley Telephones.—The Council has been considering the question of the telephone service. The granting of licenses is favoured, and the applications of the New Mutual Telephone Company and the Glasgow Corporation are supported.

Havana and Key West Cable.—We understand that the telegraph cables between Havana and Key West were interrupted and restored on Wednesday. This is the first interruption of communication since the repairs carried out by the Silvertown Company in 1882.

Hong Kong-Manila Cable.—The Eastern Extension, Australasia, and China Telegraph Company, Limited, with a view to improving telegraphic communication with the Philippines, by making it independent of the landline between Cape Bolinao and Manila, have extended their cable from Hong Kong to Manila direct.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1898 ...	...
Cayenne-Pinheiro ...	March 24th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Gurupa ...	April 4th, 1898 ...	
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Sierra Leone-Accra	April 9th, 1898 ...	...
Bolama-Bissao	„ 12th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Majunga-Tananarive ...	April 1st, 1898 ...	April 7th, 1898
Saigon-Bangkok	„ 5th, 1898 ...	„ 5th, 1898
„ „	„ 7th, 1898 ...	„ 7th, 1898
„ „	„ 9th, 1898 ...	„ 10th, 1898
„ „	„ 12th, 1898 ...	...

CONTRACTS OPEN AND CLOSED.

OPEN.

Accrington. — April 19th. The Corporation wants tenders for the supply and erection of three sets of steam dynamos, each set consisting of a triple expansion condensing steam engine of the inverted vertical type, 90 I.H.P., and of a shunt wound dynamo. Also a feed water heater, storage battery having a capacity of 750 ampere-hours, switchboard instruments, apparatus cables, wires, street boxes, connections, &c. For further particulars see our "Official Notices" April 1st. Consulting engineer, Mr. J. N. Shoolbred, 47, Victoria Street, S.W.

Belfast.—April 18th. The Harbour Commissioners are inviting tenders for the supply and erection in the electric light station, Abercorn Basin, Belfast, of three compound, two-crank, self-lubricating, single-valve quick revolution vertical engines, each capable of developing 70 H.P., with a steam pressure of 130 lbs. per square inch. Also for three belt-driven, continuous current, series wound dynamos, capable of giving 15 amperes, 2,850 volts, at a speed not exceeding 800 revolutions per minute for 18 hours continuous running, without undue heating. Specification and further particulars from the harbour engineer, Mr. G. F. L. Giles. See our "Official Notices" April 8th for particulars of these two contracts.

Belgium.—May 31st. The Municipal Authorities of Ixelles, a suburb of Brussels, are inviting tenders until May 31st for the exclusive concession for the supply of electrical energy for lighting and power purposes during a period of 26 years, that is, to September 1st, 1924. Tenders to be sent to the Secretariat de la Commune d'Ixelles, Brussels, from whence particulars may be obtained.

Bootle.—April 25th. The Corporation wants tenders for the supply and erection of arc and incandescent lamps, lamp-posts and accessories. Engineer, Mr. T. L. Miller, Liverpool. See our "Official Notices" this week.

Edinburgh.—April 23rd. The Midlothian and Peebles Lunacy Board is inviting tenders for the installation of electric light in the Asylum at Rosslynlee, near Edinburgh, including (1) generating plant, accumulators, switchboard, &c.; (2) wiring, fittings, &c. Particulars may be obtained on application to Prof. Bailey, Heriot-Watt College, Chambers Street, Edinburgh.

London.—May 17th. The Bethnal Green Board of Guardians invites tenders for the supply of plant, and installing the electric light at the new infirmary, Palestine Place. Plans, &c., to be obtained from the architects, Giles, Gough & Trollope, 28, Craven Street, Charing Cross, W.C. See our "Official Notices" this week for particulars.

Milburn, Esher.—Tenders are being invited, says *Daily Tenders*, for the running and maintenance for five years of an electrical installation, comprising gas engines, accumulators, dynamos, &c., and connected machinery. Further particulars from Messrs. O'Gorman and Cozens-Hardy, 21, Embankment Gardens, S.W.

Roumania.—April 30th. Tenders are being invited until the 30th inst. by the Roumanian Post and Telegraph Authorities in Bucharest, for the supply of 50 tons of galvanised iron wire, 10 tons of galvanised steel wire, and 5 tons of tinned copper wire. Particulars may be obtained from, and tenders to be sent to, La Direction Générale des Postes et Telegraphes, Bucharest, Roumania.

Sunderland.—April 29th. The Corporation is inviting tenders for the supply of a high-speed 225-kw. steam dynamo, and two Lancashire or Galloway boilers. Borough electrical engineer, Mr. J. F. C. Snell. See our "Official Notices" this week for particulars.

Switzerland.—April 30th. Plans and estimates are being invited, says the *Contract Recorder*, by the Government authorities of Fribourg, Switzerland, until April 30th next, for a projected electricity generating station to be established at Hauterine. Water-power is to be utilised, and the station will have a capacity of about 6,000 H.P. A premium of £120 will be awarded to the three schemes submitted which are considered to be the best. Plans and estimates are to be sent to the Department des Travaux Publics, Fribourg, Switzerland, from whence full particulars of the competition may be obtained.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

CLOSED.

Brighton.—The Council has accepted the tender of Messrs. Willans & Robinson for the supply of two steam dynamos for the electricity works for £9,591.

Derby.—The Town Council has given the contract for the supply of carbons to the English Carbon Company.

Rochdale.—The Council has accepted the tender of of Messrs. Siemens Bros. & Co. to supply steam dynamos (Belliss engines), balancer and booster, conditionally upon the granting of authority by the Board of Trade and the Local Government Board.

FORTHCOMING EVENTS.

1898.

Monday, April 18th, 8 p.m.—The Northern Society of Electrical Engineers, at Manchester. Paper on "Commercial Forms of Electrical Resistances used for Lighting and Power Purposes," by Mr. Ll. B. Atkinson.

At 8 p.m.—Society of Arts. "Sources of Commercial India-Rubber," by Dr. D. Morris, C.M.G. Two Cantor Lectures.

Tuesday, April 19th, at 8 p.m.—The Institution of Civil Engineers. Paper to be discussed:—"The Electricity Supply of London," by A. H. Preece, Assoc.M.Inst.C.E.

Thursday, April 21st, at 8 p.m.—Chemical Society, Burlington House. Papers to be read:—"The Carbohydrates of Barley Straw," by C. F. Cross, E. J. Bevan, and Claud Smith; "Isomeric Bornylamines," by M. O. Forster, Ph.D.; "Some Derivatives of Benzophenone," by F. E. Matthews, Ph.D.; "Researches on Camphoric Acid," by S. B. Schoyver, Ph.D. Ballot for the election of Fellows.

At 8 p.m.—The Institution of Electrical Engineers. "Cost of Generation and Distribution of Electrical Energy," by R. Hammond, Member. (Continuation of discussion.)

Friday, April 22nd, 5 p.m.—Physical Society. "On a Method of viewing Newton's Rings," by the Rev. T. C. Porter.

Tuesday, April 26th, at 8 p.m.—The Institution of Civil Engineers. Annual general meeting to receive report and to elect council and auditors.

NOTES.

The Electrical Resistance of Thin Films.—An article in the *Physical Review* (America) for January, by Isabelle Stone, gives an interesting account of experiments on the conductivity of thin films of silver deposited on glass by the Rochelle salt process. Many experimenters have endeavoured to construct portable standards of high resistance by means of lines and films of black lead, and of conducting powders, and have discovered how unstable such devices are. The authoress of the present paper has in each case calculated the thickness of the film from the area and mass of the deposited silver, assuming its density to be that of solid silver, and has given the resistance corresponding to that thickness. From films 10 cm. long by 1 cm. wide, and varying in thickness from about 1 to 22 millionths of a centimetre, she obtains two principle results. One is that the measured resistance is always enormously higher than the calculated, being in one case more than 100,000 times as great, and the other, that the resistance of the film always drops rapidly after formation, and continues to do so for an indefinite time, excepting in the case of very thin films, which could not be permanently maintained, and some few whose resistance, after a few days, began to increase. The changes were rapidly accelerated by heat. The experiments appear to show that the metal is deposited in an only partially coherent condition, and gradually settles down into a more compact mass. It would be interesting to know if magnetic oscillations affect the conductivity of such a film. The experiments were suggested to the authoress by Prof. Michelson, who, as is well known, uses semi-transparent films of this kind in his interferometer.

Does a Diaphragm Exist Preventing Diffusion, but not the Passage of an Electric Current?—This subject is discussed by K. Ochs in the *Chemiker Centralblatt*, No. 1, p. 289. A diaphragm that would prevent diffusion, but would allow the passage of a current, might be either (1) a membrane not permeable by the electrolyte, but permeable by the ions; or (2) a membrane permeable by the ions, and which would absorb the electrolyte, but not allow its transfusion; (3) or a membrane not permeable by either electrolyte or ions, but which allows passage of the ions when these have been deprived of their charges. Membranes of the first class are at present unknown. Those of the second order appear to be formed by precipitation of both ions in the pores of the membrane, as, for example, in the Reynier cell (a Daniell cell in which potash replaces dilute sulphuric acid), in which copper oxide forms in the pores of the cylinder, dividing the copper sulphate and potash solutions. With the continual formation of the precipitate in these cases, the resistance increases, so that any advantage obtained by the non-diffusion of the electrolyte is completely nullified. A membrane of the third order might be formed if a sufficiently thin film of mercury could be obtained, as a metal like zinc could diffuse through such a film. It does not appear, however, that such a membrane would be of any practical value. Diaphragms of the required kind for practical purposes are therefore at present unknown.

Some Researches on Electrical Conductivity.—Carl Fritsch has determined the conductivity of a number of solid substances, taken either in the form of precipitates or compressed plates, and further examined the effect which the addition of small quantities of a foreign solid has on the conductivity of the pure solid under examination. The effect of the addition of small quantities of a second salt to that which is under examination, is, in nearly all cases, to largely increase the electrolytic conductivity of the latter; this would appear to be best explained by assuming the formation of a solid solution, in which the solvent, lead chloride, for example, causes ionisation of the dissolved salt, say, potassium chloride. It is not impossible that the conductivity of the solid salts themselves is caused by the presence of traces of impurities, but this point would require specially investigating in each case. The conductivity increases rapidly with rising temperature, but the changes in the temperature coefficients are much smaller than those in the conductivities themselves. The above is an abstract from the *Annales de Physique et Chemie* (II.), No. 60, pages 300—313. Some interesting data have also been obtained by E. H. Loomis, and are given in the *Annales de Physique et Chemie*, (II.), No. 60, pages 547—551. Amongst the results the following are of interest:—

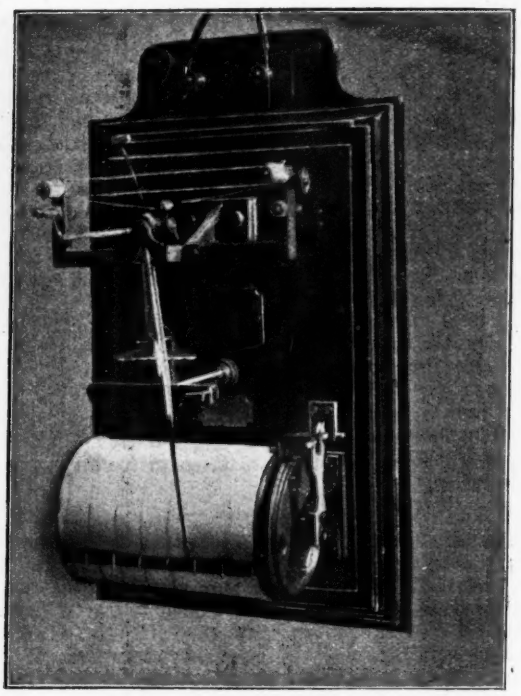
	Sp. Gr. 18°/4°.	$K \times 10^7$ at 18°.
$NaOH$	1·0418	145
KOH	1·0481	170
HCl	1·0165	279
HNO_3	1·0324	278
$1/2H_2SO_4$	1·0306	183
$1/2C_2H_2O_4$	1·0199	55

The electrical conductivities are given in mercury units of the solutions examined.

The Chemical Action of Electrical Oscillations.—This interesting subject has been carefully studied by Alexander de Hemptinne. The apparatus employed for the production of the oscillations was similar to that of Lecher (*Annales de Physique et Chemie*, 1890 (II.) No. 41, 850), and allowed of the ready alteration of the wave length. A Wimshurst machine driven at constant speed by a motor was employed in most cases, but where greater tension was required, a Tesla transformer was used. Researches with ammonia at pressures of 5 mm., 15 mm., and 50 mm., showed that the velocity of decomposition decreases with increasing pressure, and a maximum was obtained in each case some time after the commencement of the decomposition, after which it decreased, indicating a final equilibrium. The velocity is also markedly influenced by the energy of the discharge. The percentage of ammonia finally decomposed varies with the pressure, being about 50 per cent. at 49 mm., and 95 per cent. at 20 mm., but the values do not agree with the expression $p_3^2 = k\,p_1\,p_2^3$, which should theoretically obtain in the case of a heat dissociation. The decomposition is further lowered by the addition of nitrogen or hydrogen, the latter having, as expected, the greater effect, but the quantitative results are not in accord with theoretical deductions. Under the influence of electrical oscillations, nitrogen and hydrogen combine to the extent of 3 or 4 per cent., the final quantity being apparently almost independent of the pressure. In all these cases, no action occurs unless the tube containing the gas becomes luminous; and it was observed that one tube may screen another, so that if two tubes at slightly different pressures be placed between the plates and the discharge adjusted so that only one tube lightens, a slight increase of pressure in this tube causes it to become dark, and the second tube to lighten and be decomposed. Carbon bisulphide is also decomposed, the velocity being well represented by the equation $dx/dt = k(a-x)$. Some thick liquids, such as glycerol, exhibit an increase of vapour pressure when exposed to the action of the oscillations, a similar effect occurring with oxalic acid, whilst calcium chloride appears to be entirely unaffected. The above is an abstract of a paper in the *Zeitschrift fur Physikalische Chemie*, 1897, No. 22, pages 360-372.

Lecture.—Bailie Mackenzie, convener of the Electric Lighting Committee of Edinburgh Town Council, on 11th inst. addressed the members of the Edinburgh Association of Science and Arts on "Progress of the Electric Light in Edinburgh."

Continuous Recording Voltmeter.—The use of recording voltmeters, as at present made, necessitate for every instrument the filing of 365 charts every year, as well as daily attention and changing of the same. It is true that there is an instrument in the market with a continuous strip which obviates the daily attention but does not reduce the trouble of keeping the records. To improve this, the engineer at the Cambridge Electricity Works devised and adapted instruments already in use to run on the same chart for a week.



The principle of moving the drum along its spindle most naturally suggested itself, and as a matter of fact was included in the application for patent, but to do this would render the horizontal length of the instruments much greater, and would not admit of the ready adaption of existing instruments to the continuous movement. The arrangement of cams and general principle is said to be shown on the accompanying illustration, but this is open to doubt. We understand that the principle is patented, and is applicable to most recording instruments.

Workmen's Compensation Act and Electricity Works.—At the St. Pancras Vestry's meeting of Wednesday evening it was reported with reference to the Workmen's Compensation Act, 1897, which comes into operation on July 1st next, that a letter had been received from the Home Secretary, in reply to a communication from the Vestry, stating that "he is advised that electric lighting works, where electricity is generated by the use of mechanical power, and is supplied to consumers, are factories within the Factory and Workshops Acts, and therefore the Workmen's Compensation Act will apply in all such cases."

The Shannon Electric Power Scheme.—A specially convened meeting of the Limerick Fishery Conservators was held on 7th inst. to hear a deputation from the Shannon Electric Power Syndicate with reference to the pending scheme for utilising the River Shannon in the production of electricity. Lord Lurgan, Colonel Sir Gerald Dease, Mr. H. J. Fuller, engineer, and other directors, attended to explain modifications of the original scheme. That scheme proposed the impounding of Lough Allen, and the conversion of the lake into a storage reservoir, the waters to be utilised on the gravitation principle. In reply to questions, Mr. Fuller said the horse-power to be used all the year round at the works at Castle Connell would be 5,000, the *maximum* being 10,000.

The Economy of the Corliss Engine.—The success of the Corliss engine, as a machine in respect of its steam economy, has, in a sense, not been an unalloyed blessing. That the engine was economical in steam may have been true, but the credit was given to the principle of variable expansion and sharp cut-off. Designers of engines sacrificed everything to a sharp cut-off corner in the indicator diagram, and this was very greatly over-rated, as though special economy arose from it. The claims of the Corliss engine are discussed by our American contemporary, *Machinery*, and the true cause of economy announced, or rather, re-announced. This, of course, is the use of separate valves for steam and exhaust, and the position of the exhaust valve on the lower side of the cylinder, whereby it is enabled to more readily drain the cylinder of water. If the ordinary arrangement be noted, it will be seen that the exhaust valve is so placed as to at once catch any water shot into the cylinder from the steam valve, and also to drain any water which tries to collect in the cylinder. The outrush of the exhaust carries a large proportion of water with it before re-evaporation can occur during the exhaust stroke. This is the great reason for economy. With exhaust valves placed in the cylinder covers, and thus not at the lowest part of the cylinder, we think there would be far greater steam consumptions registered. As we have already observed, the economy of the Corliss engine, really due to good valve arrangement, was long credited to fanciful notions as to shape of cut-off corners, and variable expansion, as though, for example, an automatic variable cut-off could have much influence on the economy of a cotton factory engine, which scarcely varies its power the day through; and the Corliss engine is not the only example showing wrongly credited economies.

Caoutchouc and Gutta-Percha Cements.—A gutta-percha cement for leather is obtained by melting together 100 parts gutta-percha, 100 parts asphalt or pitch, and 15 parts oil of turpentine. It is to be used hot. Elastic gutta-percha cement, especially for fixing soles to shoes, which does not crack in bending, on account of its great extensibility, is, according to an article in the *Färben Zeitung* translated in the *Scientific American*, prepared by dissolving 10 parts gutta-percha in 100 parts benzine and pouring the solution into 100 parts linseed oil varnish, shaking well. The leather must be roughened before using this cement, in order to insure greater durability. By a caseine-borax cement a handsome surface gloss is imparted to the leather. The borax is dissolved in boiling water and the borax solution poured into freshly prepared caseine. The durable thick cement is very serviceable. Good caoutchouc cements, for rubber strips or rubber goods on metal, are obtained by dissolving shellac in ten times its weight of ammonia. After standing for three to four weeks a transparent putty results, which is used without heating. The cemented places soften at first, but become hard and firm after evaporation of the ammonia, which may be assisted by heating. This cement is watertight and gasproof, and is also useful for hard rubber articles. A cement made of a mixture of gutta-percha with asphalt is serviceable for the same purpose. This has to be applied hot and the pieces are to be pressed together. Very useful cement for leather belting is manufactured by kneading 10 parts carbon bisulphide and one part of oil of turpentine with gutta-percha until a thick paste results. The portions of the leather where the cement is to be applied must be unoiled and roughened; the cement is put on and the ends are pressed together until the binding agent has become dry. Directions for caoutchouc cements are: 100 parts finely cut caoutchouc, 15 parts resin, 10 parts shellac, dissolved in sulphide of carbon. One part caoutchouc, seven parts mastic, and 50 parts chloroform, left to stand several weeks.

The Civil Engineers' Incoming President.—At the recent banquet of the Institution of Civil Engineers, Sir J. Wolfe Barry announced Mr. W. H. Preece, C.B., as the incoming president, and he dwelt upon the fact that Mr. Preece will be the first electrical engineer to occupy the chair. This may be taken as an index of the important position occupied by electrical science to-day in all branches of engineering, and we congratulate Mr. Preece upon being the first of a lengthy list of coming electrical presidents of this Institution.

A New Application of the Röntgen Rays.—The *Times* correspondent at Vienna says that some interesting particulars of a new application of the Röntgen rays for curative purposes were communicated by Dr. Edward Schiff, lecturer at the Vienna University, at the last sitting of the Imperial and Royal Medical Society. A series of experiments conducted by Dr. Schiff and his assistant proved that these rays could be used for the cure of disease in a manner capable of perfect control by means of a more or less intense application for a longer or shorter period, producing reaction in the exact degree required. In this way it has been possible for the lecturer, on the one hand, to remove hair from parts of the body where it constituted a disfigurement without causing the slightest inflammation, while, on the other hand, he has been able to treat lupus with uniform success by means of an artificial inflammation, the intensity of which he was in a position to increase or reduce at will. The results secured by the new method both in the removal of superfluous hair and the treatment of lupus were demonstrated in the persons of some of Dr. Schiff's patients.

Electric Drill in Shipyards.—We illustrate below an electric drilling machine engaged on drilling the rudder frame of the Japanese battleship *Shikishima*, 14,950 tons, at the works of the Thames Ironworks and Shipbuilding Company, Limited. This illustration shows very forcibly the advantage of being able to take such a tool to the work, instead of having to take the work to fixed machine tools in the shops. We understand that the performance

of the machine in question has been very good, as by its use one man and a boy have drilled $\frac{3}{8}$th-inch tapping holes, $1\frac{1}{4}$-inch deep, in the rough cast-steel of which the rudder is composed, at the average rate of rather more than 100 per working day of eight hours. This was not on test holes, or anything of that sort, but is taken from the weekly work record sheet, the time including all shifting and setting up of the machines, grinding drills, and so on. We understand that the Thames Ironworks Company makes these drilling machines in a variety of patterns and sizes.

Obituary.—We hear with great regret of the death, under very sad circumstances, of Mr. Nelson W. Perry, who until very recently was editor of New York *Electricity*. On March 26th he was experimenting in his laboratory at Brooklyn, and when the gas was turned out he drank bichromate of potassium instead of a glass of water. He immediately called for medical and other assistance, but all efforts were of no avail, and he died the following night. Mr. Perry was extremely popular among the electrical fraternity in the States, and his name is also well known in this country, his papers read before the American Societies on various subjects having been reprinted in the press on this side. He will also be remembered as an occasional contributor to *Cassier's Magazine* and other journals. Mr. Perry was only 45 years of age, and but for the sad accident mentioned would still be continuing his researches in electrochemistry and the other branches of electrical work to which he was devoted. In his earlier days Mr. Perry practised in mining engineering, and at one time held the chair of metallurgy at the University of Cincinnati. He went into electrical engineering in 1887, and was connected with several leading electrical manufacturing companies, and in 1891 became associated with *Electricity*. He was a member of various New York and Continental scientific societies. His lengthy contribution to the National Electric Light Association in 1895 on the storage of energy essential to economy of working in central stations appeared in the Electrical Review during March and April of that year.

The Late Strike.—A "Working Man" writes a long letter to *Engineering* anent the late engineers' strike, with special reference to the bearing of Sir Richard Tangye, of whose gift of £500 to each side he does not approve. He thinks Sir Richard ought to have joined the Federation and locked out the men who were unionists instead of helping to prolong the strike by supplying funds more or less directly for the unionists to hand over to Mr. Barnes. "Working Man" also recommends working men to study the past eight months' newspapers, and they will find that the labour leaders have been addressing so many meetings at *so much and their expenses*, which means that these men were reaping a golden harvest while their dupes and paymasters were walking about in idleness. He further suggests that with the £500 returned to him by the employers and the £500 which the A.S.E. ought to return to him, Sir Richard should either make a payment to his 2,500 men, or should start a fund to send a few of the more intelligent and young men to travel abroad and visit the great foreign industrial centres so as to get at facts which, if known, would go far to prevent future strikes, and so make it necessary for labour agitators to work honestly for their living. If it had not been for the Employers' Federation it might have been Sir Richard would not have had £1,000 to give away, and if his men had been unionists all his boasted friendship with them would have availed nothing if the A.S.E. had ordered the men out, for out they would have had to come or lose all accumulated benefits. "Working Man" seems to know of what he speaks, and does not much love the conduct of the A.S.E., and makes a good point of his description of the behaviour of mild-mannered deputations to employers and the braggadocio of the same deputies when speaking at unreported meetings. He concludes that neither the men, the masters, nor the country at large have gained by the strike, but only the agitators, who have reaped gold out of their fellows' idleness and starvation.

The Voltmeter on Series Arc Lighting Circuits.—In an article which appeared recently in the *Electrical Review* of New York, our contemporary draws attention to the frequent neglect of the use of voltmeters on series arc circuits in America, although its employment in such a case is quite as necessary as that of an ammeter on a constant potential circuit, since on a constant current circuit it is the voltmeter reading which measures the output of the machine at any given moment. Besides being necessary for the measurement of output, the voltmeter is a most useful addition to the testing equipment, as, by its means, the existence, locality, and approximate resistance of a fault can be indicated whilst the circuit is running. The utility of the voltmeter as a testing instrument has long been recognised by English engineers, and we know of arc lighting circuits which are regularly tested by means of an electrostatic voltmeter, which is connected between one terminal of the circuit and earth, so as to show the potential difference between that terminal and the fault, and thus indicate its position if the drop of volts per lamp is known. The electrostatic voltmeter, however, gives no indication of the fault resistance, and, further, if the potential difference between one terminal and earth is half that between the two terminals, one cannot say whether there is a fault halfway round the circuit or not, as the same reading would be obtained if the insulation were practically perfect and the small leakages which must always exist were equally divided over the circuit. This difficulty is obviated by the use of an electro-magnetic voltmeter of known resistance, and our contemporary describes one which has been brought out by the Keystone Electrical Instrument Company, and which is said to give very satisfactory results, as it is dead-beat, direct reading with a practically uniform scale from zero to the maximum reading, and is made for use on circuits up to 6,000 volts, without requiring the addition of any external multiplying resistance box. With an electrostatic voltmeter, if A is the potential difference between the positive terminal and earth, and D the drop of volts per lamp, and if there are N lamps between the positive terminal and the fault, the position of this latter is indicated by solving the equation $N = \frac{A}{D}$. With the electro-magnetic instrument it is necessary to make two other measurements, B the potential difference between the negative and earth, and C that between the positive and negative, and the value of N is then given by the equation $N = \frac{A\,C}{D\,(A + B)}$. Also if the R is the resistance of the voltmeter, and R′ that of the fault, the value of the latter is given by the formula $R' = R\,\frac{C-(A+B)}{A+B}$. It will be noticed that if R′ is very small compared to R, the sum of the two readings A + B will be very nearly equal to C, and in the extreme case when equality exists the multiplier $\frac{C}{A+B}$ being unity, the equations for the two types of voltmeter become the same.

Operation of T.-H. Arc Dynamos.—As I have never seen anything in print about caring for Thomson-Houston arc dynamos, I venture, says Mr. C. C. Giles in the *American Electrician*, to send a few suggestions about these troublesome machines. In the first place, the commutator, brushes, and brush-holders should be well cleaned after every run. Adjusting the machine with too short a spark will cause "flashing." The spark can be lengthened by turning the commutator slightly forward on the shaft. This weakens the machine, however, and if it is well loaded, care should be taken not to weaken it so much as to cause the regulator to rest on the stop. The commutator should not be moved more than $\frac{1}{16}$ inch at a time. Much trouble is sometimes caused by the air-blast being worn out. The hubs should fit snugly in their bearings in the sides of the air-blast. I have seen them with as much as $\frac{1}{16}$ inch play. The General Electric Company will repair them much more cheaply than new ones can be obtained for. I have obtained the best results by adjusting the air-jets so that the blast will strike about $\frac{1}{4}$ inch in front of the brushes when the regulator is down. Of course, if the machine has to work with a light load, this cannot be done. If the load is very light the armature will get quite hot. This can be remedied by connecting a rheostat between the binding post and connecting-rod post on the right-hand leg of the machine. This weakens the field and causes the regulator to run lower. The height at which the regulator runs can be adjusted by turning the rheostat. It should not be more than $\frac{1}{2}$ inch from the top. When the rheostat is in use, the spark will be longer than usual, and may be a little harder on the segments and brushes, but these are cheaper than armatures. The rheostat should have not less than 60 ohms resistance.

Local Authorities and Electric Lighting.—The following letter on a very important subject appeared in the *Times* the other day above the signature "Electron." The writer says :—

A list has just been published of local authorities to whom provisional orders for supply of electricity have been granted by the Board of Trade, but in respect of which no works have yet been decided upon. The list in question contains the names of no less than 83 towns, the orders being granted between the years 1890 and 1897, of which number 11 have remained in force over seven years without being dealt with. Under the Electric Lighting Act and the practice of the Board of Trade a preference is given to applications by local authorities, commercial enterprise being excluded in the desire to promote the municipalisation of electric supply. This action has given, as may be judged from the above statement, great power to the gas interest and other adverse influences among town councils, vestries, and boards of works in preventing any practical application of the Electric Light Acts. I notice that an arrangement has recently been come to between the Board of Trade and the Marylebone Vestry for granting a provisional order to the vestry in the Session of 1899, on condition that the clauses authorising a transfer of the undertaking to private firms or companies are eliminated. If this be an indication of a change of policy on the part of the Board of Trade, the abuses I have referred to will be prevented in the future, but in order to deal with the deadlock in this important industry in the 83 towns of which the names have been published, I submit that a time limit should now be fixed by the Board of Trade within which the works are to be carried out or the powers transferred to others or absolutely revoked.

This letter is followed by a more lengthy one signed by "A Burner of Electricity and Ratepayer of Marylebone," who says :—

The Vestry of Marylebone is seeking powers to compete with the existing company supplying the district. The policy of allowing vestries to use the money of the ratepayers for large commercial undertakings is doubtful in any case, but where it is to be employed to compete with an existing company for electric lighting it is especially so. If it could be shown that in a particular parish private enterprise had failed to supply an efficient light, there would be some justification in the local authority undertaking the work; but for a vestry to deliberately embark in the lighting business in order to compete with an existing company requires strong arguments for its justification. In order to do this it would have to be shown that the costly competition would ultimately benefit the consumer by cheapening his light. A little consideration will show the fallacy of this assumption. In order to supply electric light cheaply, two conditions are essential; the one is to minimise the capital expenditure, the other to keep down the working expenses. Instead of doing this, the effect of the Vestry competing would be exactly to double the capital, and nearly to double the working expenses. There would have to be erected and equipped costly generating stations, and there would have to be buried in the ground hundreds of miles of cable. The stations would be in close juxtaposition to the existing works, while the cables would have to lie side by side with the present network, the existing works and cables being already amply sufficient. Then, when all the works had been constructed, the whole of the annual working expenses, maintenance, and supervision would have to be provided for. Now, who ultimately has to pay for all this useless expenditure? Undoubtedly the consumer will have to do so! Neither a vestry, any more than a private company, can afford to sell light at less than cost price; the only way, therefore, to benefit the consumer is to decrease the cost of production. This is what is occurring in districts now supplied by first-rate companies, who find that as the number of lamps connected with their systems increase so much the more cheaply in proportion can they supply the light. This, and not competition, is the explanation of the rapid reduction in price going on. Four years ago, in the parish in which I am writing, and in which, up to the present time, there has been no competition, we paid nearly double what is now charged for the light, and believe as the company increase their business so will it be their interest still further to reduce the price. The safety to the consumer consists, not in useless and expensive competition, but in the fact that every electric company is doing its utmost to produce cheaper, so that the price charged for electric light may compete successfully with gas and mineral oil. If the present companies are only allowed to develop without ruinous competition with the vestries the time cannot be far distant when every householder will get this healthy light at as cheap a rate as he now pays for his gas or lamp.

The Production of Electricity by Chemical Means.—Up to the present it can scarcely be claimed by any inventor that he has succeeded in producing electricity by depending solely upon chemicals. There are a great many whose attention has been devoted to this branch, but the problem of economical production yet remains to be solved. Ernst Andreas (*vide Zeitschrift fur Electrochemie*, 1895, No. 3, page 188), has recently been examining Borcher's cuprous chloride carbonic oxide cell, using carbon electrodes dipping respectively into solutions of cupric chloride in water, and of cuprous chloride in aqueous hydrochloric acid. A porous diaphragm separated the two solutions, chlorine being passed into the cupric, and carbonic oxide into the cuprous solution. After a time the current rapidly diminished, and it was found that the cuprous chloride was completely oxidised. The carbonic oxide had taken no part in the change. Of 1,950 cc. used in one experiment, 10 cc. only were oxidised to carbonic anhydride. Similar results were obtained with electrodes of platinum, palladium, or nickel at various temperatures. A gas battery, consisting of two pieces of platinum gauze separated by a sheet of filter paper moistened with the solution of an electrolyte, had a very low resistance, and gave very encouraging results with coal-gas and air, oxygen and hydrogen, or chlorine and hydrogen. The last combination, with the gases under a pressure of about three atmospheres, gave a current of about 1 ampere at 1·5 volts. Owing to the cost of the platinum, such a cell could not be a commercial success; but fairly good results were obtained by passing sulphurous anhydride on the one hand and chlorine on the other, under pressure, into carbon tubes dipping into dilute sulphuric acid. This combination gave 0·5 volt, with 1 ohm resistance in circuit, and the products are sulphuric and hydrochloric acids. With large electrodes, good results would probably be obtained with air and sulphurous acid, in which case the product would be sulphuric acid alone.

The Parliamentary Electricity Committee.—The Electrical and Allied Trades Section of the London Chamber of Commerce passed the following resolutions on March 24th:—

1. That the Electrical Section of the London Chamber of Commerce is of opinion that the principle of the reference to the Joint Committee of the Houses of Lords and Commons on electrical energy (generating stations and supply) should be supported.
2. That the various municipalities and companies interested in electric lighting be asked to support the principles contained in the reference to the Joint Committee.
3. That a Committee be appointed (with power to add to their number) to take such action with regard to the inquiry of the Joint Committee as may be deemed advisable.

Relative Economy of Steam Plant in Electrical Stations.—We quote from an article by M. Van Kesteren on the "Construction of Tramway Lines for Electrical Traction," that appeared in the *Bulletin* of the Association of Electrical Engineers of the Montefiore Institute, the following table, which shows the influence of the choice of the steam plant used on the maintenance and working expenses of electrical stations:—

Mode of production of electrical energy.	Price per car kilometre.
Direct-coupled Corliss engine, of a power above 1,000 I.H.P.	·137 to ·19 francs.
High speed compound condensing engine, with belting power above 600 I.H.P. ...	·206 to ·293 „
High speed compound tandem non-condensing engine, with belting power above 400 I.H.P.	·208 to ·296 „

E. P. (*L'Electricien*).

Geneva Electrical Trust.—The *Financial News* says that there has been a good deal of talk recently about the formation of an Electrical Trust, with a capital of a million sterling, at Geneva. The project has at length assumed definite shape. The chief mover in the matter is the Union Financiere. Berlin is finding some of the capital, but London is responsible for the major portion.

NEW COMPANIES REGISTERED.

Electric Light and Power Company, Limited (56,786).—Registered April 1st, with capital £6,000 in £1 shares (5,000 deferred), to carry on the business of an electric light company and supplier of motive power, and the business of electricians, electrical, mechanical, and general engineers, electrical apparatus manufacturers, &c. The subscribers (with one share each) are:—R. S. Rose, 44, Wharncliffe Gardens, N.W., stenographer; R. F. W. Martin, Clarendon Villa, Ashford, Middlesex, electrical engineer; P. H. Drake, 19, St. George's Road, Wimbledon, clerk; A. Scott, 11, Barton Street, Westminster, builder; D. Hays, 15, Montpelier Road, Ealing, electrical engineer; S. M. Powell, St. Faith's Road, Norwood, secretary; O. S. Phillpotts, 2, St. Mary's Terrace, Paddington, clerk. Registered, without articles of association, by Markby Stewart and Co., 57, Coleman Street, E.C.

New Electricity Supply Syndicate, Limited (56,815).—Registered April 2nd, with capital £40,000 in £1 shares to adopt an agreement with A. T. Salisbury-Jones, G. L. Bidwell, and F. W. Salisbury-Jones, and to promote, construct, equip, maintain, manufacture, improve, work and manage electrical works and appliances for electrical lighting. The subscribers (with 100 shares each) are:—Lurgan, Lowndes Square, S.W., peer; F. B. Jameson, 29, Kildare Street, Dublin, distiller; J. Hone, Roebuck Grove, Dennybrook, director; J. Chambre, Mespt House, Dublin, merchant; T. B. C. Hardman, 14, Molesworth Street, Dublin, solicitor; G. E. H. Trevor, 14, Onslow Square, S.W., gentleman; A. A. Baumann, 109, Queen's Gate, S.W., barrister. The number of directors is not to be less than two nor more than seven. The first are Lord Lurgan, and A. A. Baumann; qualification, 50 shares; remuneration, £2,000 per annum divisible. Registered by F. King, 28, Park Road, Wandsworth Common.

Yarmouth (Isle of Wight) Electricity Supply Company, Limited (56,884).—Registered April 7th, with capital £5,000 in £5 shares, to carry on in Yarmouth, Isle of Wight, and elsewhere, the business of electricians, electrical and mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with one share each) are:—Heytesbury, Heytesbury, Wilts, peer; R. H. H. Eden, Heytesbury, Wilts, land agent; B. M. Aubyn, Tapnell Farm, Freshwater, Isle of Wight, land agent; F. Christy Chelmsford, electrical engineer; Mrs. C. Edmonds, The Retreat, Yarmouth, Isle of Wight; J. T. Harwood, Yarmouth, Isle of Wight, ironmonger; C. Edmonds, Yarmouth, Isle of Wight, solicitor. The number of directors is not to be less than three nor more than five; the first are Lord Heytesbury, R. H. H. Eden, C. Edmonds and B. M. St. Aubyn; qualification, two shares; remuneration, £50 per annum, divisible. Registered by Ford & Co., 6, Dowgate Hill, E.C.

J. Goodman & Co., Limited (56,886).—Registered April 7th, with capital £7,000 in £1 shares, to acquire the business of J. Goodman & Co., of 48, Commercial Street, London, and to carry on the business of electric supply merchants and dealers, electrical engineers, &c. The subscribers (with one share each) are:—J. Goodman, 11, Navarino Road, Dalston, merchant; D. J. Mihr, 7, Dempsey Street, Stepney, clerk; E. Gutmann, 17, St. Phillip's Road, Dalston, traveller; W. Musk, 30, Mount Street, Bethnal Green, E., lamp maker; W. Ashley, 76, Bird-in-Bush Road, Peckham, electric lamp maker; W. Tatum, 65, Shrubland Road, Dalston, painter; R Sendal, 21, Yotton Street, South Bromley, E., engineer. J. Goodman is the sole managing director. Remuneration as fixed by the company. Registered by H. C. Davis, 52, Allison Road, Harringay, N.

CITY NOTES.

The Indo-European Telegraph Company, Limited.

In the report for 1897 the directors express their deep regret at the loss of the valuable services of their late colleague, Mr. C. W. Earle, who died last June, and who had been connected with the company since 1881. The company's revenue from all sources for 1897 amounted to £130,347 3s. 5d., as compared with £123,539 17s. 11d. for 1896, showing an increase of £6,807 5s. 6d. The expenses were—on commercial and general account, £36,765 11s. 5d.; on maintenance account (expenses and charges) £32,613 2s.; total £69,378 13s. 5d., as against £68,105 10s. for 1895, an increase of £1,273 3s. 5d. Deducting the above expenses, taking credit for £7,704 3s. 2d. brought over from 1896, and debiting income-tax, there remains the sum of £66,573 4s. 1d. From this amount £15,000 has been placed to reserve, and that sum, together with £10,625 amount of interim dividend, have to be deducted, leaving a balance of £40,948 4s. 1d. The directors now propose the declaration of a dividend for the six months ending December 31st of 17s. 6d. per share, making, with the dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of income-tax, making in all 10 per cent. for the year, carrying forward £9,073 4s. 1d. to the credit of 1898. The balance carried forward is rather larger than usual; there are, however, several items involving an increase of expenditure that will have to be provided for in the year 1898. The lines of the company continue to work satisfactorily, and the introduction of the Wheatstone automatic apparatus has proved successful: the system is being extended. Mr. T. W. Andrews has joined the board. The following directors retire

by rotation, and offer themselves for re-election:—H. H. Meier, Esq., and J. Herbert Tritton, Esq.

In case any shareholder should be unable to attend the general meeting, he is requested to fill up and return the proxy form, duly signed, so as to reach the company's office not later than 12.30 p.m. on the 18th inst.

Oldham, Ashton, and Hyde Electric Tramway Company, Limited.

The first ordinary general meeting was held last week at Donington House, Norfolk Street, Strand, Mr. Emile Garcke presiding.

The Chairman stated that they had been called together to comply with the Companies' Act, which provided that a meeting should be held within four months from the date of the company's registration. The company was registered on December 18th, and the prospectus was issued in the following month. The whole of the capital offered for subscription, consisting of 4,000 5 per cent. cumulative preference shares and 4,000 ordinary shares of £10 each, was subscribed for and allotted. They lost no time in applying for a quotation on the Manchester Stock Exchange, and they were informed that, subject to their complying with a small formality, the quotation had been granted. The progress made with the works had been satisfactory. Out of the eight miles of tramways two-and-a-half miles were already constructed, and other portions were in course of construction. They were informed by the engineers that the work throughout was satisfactory; and the borough engineers of the district were, he was informed, also satisfied with it. Several gangs were employed on the works, which, they were given to understand, would in all probability be completed in July next. The contract for the electrical portion of the work was being carried out by the British Thomson-Houston Company, and they were informed that satisfactory preparations were also being made with the view to that part of the work being carried out expeditiously. They only hoped that there would be no delay on the part of the Ashton Corporation with the completion of their part of the work, so that they might have the tramway in full working order in the early autumn. The Ashton Corporation had made an agreement with the company, under which the latter would be supplied with electrical energy. He hoped when they met early next year they would be able to report, not only that the work was completed and the line opened, but that they had been already carrying and had secured a considerable amount of the local traffic. They would by that time be in a better position to state what the volume of their traffic was, but so far, they had seen no reason whatever to modify the estimates they had formed.

Mr. Alderman T. Heginbotham, the representative on the board of the Ashton Corporation, stated that the latter were doing all that they possibly could to get the engines at work, and they were well alive to what they had to do.

No business resolution was submitted to the meeting.

British Electric Traction Company, Limited.

The ordinary general meeting was held on Thursday at Donington House, Norfolk Street, Strand, Sir Charles Rivers Wilson presiding.

In moving the adoption of the report, the Chairman said he was glad to be able to state that already, at the end of their first year's operations, they had succeeded in establishing a business of considerable magnitude, and one which they had every reason to believe would become profitable to the shareholders. The gross profits for the 14 months covered by the accounts, from the date of the formation of the company to the end of 1897, amounted to £14,422, and after deducting such of the general expenses as were chargeable to revenue account, and also the expenses incurred in connection with schemes and undertakings they had thought it well to initiate, but which, for various causes, they had afterwards dropped, there remained a profit of more than £9,800. The directors did not consider it expedient that this net profit, which represented about 3½ per cent. on the capital employed during the year, should be distributed in dividends. The extensive business they were building up required that the company should occupy a strong financial position, and, in the opinion of the board, it would be more to the interests of the shareholders that the amount in question should be carried forward to next account. Original shareholders would remember that the whole of the ordinary shares were offered for subscription at the time of the formation of the company, but they were not all subscribed for, and in order to secure a quotation on the Stock Exchange the Electric and General Investment Company, and their friends, made up the subscription to 20,000 shares, and the remaining 10,000 shares were subsequently issued at a small premium. Last month the directors made an issue of 10,000 6 per cent. cumulative preference shares of £10 each, and the strong position the company occupied enabled them to be issued at a premium of £2 10s. per share. The proceeds of such issue would come into the accounts for the current year, and he might add that it was exceedingly probable that occasion would arise during 1898 for further issues of capital. He then referred to the various items in the balance-sheet and profit and loss account. With regard to the investments, £148,179, he said that this item would always remain relatively large, as it included debentures and shares held in certain associated companies, and the more they developed their business the larger would become their investments in subsidiary and other companies. The fact that the company had received nearly £3,000 in dividends in respect of the past year, although many of the investments were not made until towards the end of 1897, was evidence that they were of a remunerative character. Having alluded to a number of the important schemes which they were developing, he said it would serve to give the shareholders some idea of the magnitude of their business when he told them that they had upwards of 50 schemes under consideration, and that the agreements and contracts they had entered into and the concessions they had either obtained or applied for covered a total mileage of electrical tramways and light railways in the United Kingdom of more than 200 miles. Moreover, it was not looking too far into the future to say that a total capital expenditure of between £2,000,000 and £3,000,000 would have to be provided. Owing to the spirit which was abroad among the larger corporations to municipalise their tramways and similar undertakings, the board had, on more than one occasion, been discouraged from initiating undertakings within particular boroughs. To a certain degree that was a matter for regret. He was of opinion, not because he was associated with this company, that work of the sort in which they were interested could be better and more usefully carried out by means of a company such as theirs than by a corporation. A municipality was only able *prima facie* to carry out operations within the limits of its own boundaries, and inasmuch as for the economical and efficient working of tramways—particularly electric tramway enterprises—it was necessary there should be communication with outlying villages and other towns, they would see at once how desirable it was that the lines should be constructed on a uniform system and be, as far as possible within the district, under a single management. One might be in favour of municipalisation of electric lighting, because that was a business which could be confined within a given borough, but undertakings like tramways or railways, which depended for their success on the efficiency with which people could be moved about from one borough to another, were surely not suitable for municipalisation. He concluded by an expression of regret at the death of the Earl of Suffolk, who, he said, was only that day fortnight at a meeting of the board, of which he had been a member since the formation of the company.

Mr. Emile Garcke (managing director) seconded the motion, which was agreed to unanimously.

An extraordinary general meeting was then held, at which resolutions were passed approving several proposed light railway orders.

Douglas Southern Electric Tramway.—The directors of the Douglas Southern Electric Tramway, Limited, report a profit for last year of £736. Out of this sum, together with the balance brought forward, a dividend of 3 per cent. on the 7 per cent. preference shares is recommended, carrying forward the balance of £265. The retiring directors, Messrs. Lowcock and Fawcus, of Manchester, decline to offer themselves for re-election.

St. James's and Pall Mall Electric Light Company.—The amount of electricity sold for the quarter ended March 25th is returned at 1,016,642 units, estimated to produce £21,180, as against 907,919 units for the same quarter of last year, which produced a net revenue of £19,898. A further reduction in the scale of charges made by the company came into force on January 1st, 1898.

Oriental Telephone and Electric Company, Limited.—The directors have resolved to recommend to the shareholders, subject to the final audit of the accounts, a further dividend of 8d. per share, free of income-tax, making, together with the interim dividend paid in October last, 5 per cent. for the year ended December 31st, 1897.

The Submarine Cables Trust.—This company announces that, on and after April 15th, the coupon due on that date will be paid in full by Messrs. Glyn, Mills & Co., of 67, Lombard Street, E.C., between the hours of 10 a.m. and 2 p.m. The coupons should be left with the bankers for examination four clear days before payment.

British Columbia Electric Railway Company.—The half-yearly interest on the 4½ per cent. debentures, and on the 6 per cent. income bonds, due 15th inst., will be paid on and after that date at the offices of Messrs. Sperling & Co., 8, Austinfriars, E.C.

Eastern Extension Telegraph Company.—Numbers are advertised of 451 debentures of £100 each, which will be paid off at par on July 1st next at Messrs. Barclay & Co., 54, Lombard Street, E.C.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending April 8th, 1898, were £2,810 9s.; corresponding period, 1897, £2,078 0s. 3d.; increase, £732 8s. 9d.

The City and South London Railway Company.—The receipts for the week ending April 10th, 1898, were £884; week ending April 11th, 1897, £1,021; decrease, £137; total receipts for half-year, 1898, £15,826; corresponding period, 1897, £15,839; decrease, £13.

The Dover Corporation Electric Tramways.—The receipts for the week ending April 2nd, 1898, £117 16s.; total receipts to April 2nd, 1898, £1,395 14s. 7d. Week ending April 9th, 1898, £119 2s. 7d.; total receipts to April 9th, 1898, £1,514 17s. 2d.

The Liverpool Overhead Railway Company.—The receipts for the week ending April 10th, 1898, amounted to £1,539; corresponding week last year, £1,353; increase, £186.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending April 8th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,581.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	Name.	Stock or Share. †	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, April 5th	Closing Quotation, April 13th.	Business done during week ended April 13th, 1898. Highest.	Lowest
137,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 —104	100 104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	61 — 64	61 — 64	...	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	111½ 112½	111½ 112½	112½	111½
3,038,020£	Do. do. Defd.	Stock	...	...	...	12⅝— 13½	12⅝— 13½	13	...
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	7 %	16½ - 17 xd	16½ - 17	16½	...
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	8 %	...	185 —190 xd	185 —190	...	...
918,297£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	104 —106 xd	104 —106	105½	104½
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1¼%	2 %	...	⅛— ⅜	⅛— ⅜	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	7 %	6½— 7½	6½ — 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14½ - 15½	14½ - 15½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 5,000 ...	50	4½%	4½%	4½%	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10⅜ - 11½	10⅜ - 11½	...	...
120,000	Direct West India Cable 4½% Reg. Deb	100	...	...	...	99 —102	99 —102	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17⅜ - 18½	17⅜ - 18½	18 1/16	17⅞
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18½— 19½	18½ - 19½	...	...
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103	100 —103	101½	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	128 - 131	128 —131	128½	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18⅜ - 19¼	18⅜— 19¼	19	18⅜
25,200£	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,849, 3,976 to 4,325	}100	5 %	5%	...	99 - 103	99 - 103	...	...
100,500£	Do. do. Bearer, 1,850—3,975 and 4,327—5,400	100	5 %	5%	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4%	...	128 —131	128 —131	...	...
35,100£	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	}100	5 %	5%	...	99 —103	99 —103	...	...
46,500£	Do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1929	100	4 %	4%	...	102 —105	102 —105	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 3,000	25	4 %	4%	...	107 —110%	107 —110 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11⅜ - 12¼	11⅜ - 12¼	12	11 11/16
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17½ - 18	17½ - 18	17 9/16	17½
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	29½ - 30½	29½ - 30½	...	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5%	...	100 —103	100 —103	...	...
97,000	{ Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	95 —100	95 —100	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 —109	106 —109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	4 %	2 — 2½	2 — 2½	...	...
484,597	National Telesph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	5½— 6	5½ - 6	5⅝	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5½ - 6	5½ - 6	5½	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	100 —105	100 —105	103	101
171,504	Oriental Telesph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅜ - ½	⅜ - ½	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 —145	140 —145	...	..
58,000	United River Plate Telesph., Ltd.	5	4 %	5 %	...	4 — 4½	4 — 4½	4 7/16	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	...	...	105 —108	105 - 108	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	*nil*	...	3½ - 4½	3½ - 4½	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5%	...	99 —102	99 - 102	100½	...
64,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	12 — 12½	12 — 12½	12½	12⅛
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7⅞— 8¼	7⅞— 8¼	7⅞	...
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	...	4½— 5	4½— 5	4⅜	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	106	...
88,321	West India and Panama Teleg., Ltd.	10	3%	1 %	...	½— ⅝	½— ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	7½— 8	7½ - 8	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	105 —108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100£	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13½— 14½	13½— 14½	...	...
20,000	Do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	10½— 10⅝	10½ - 10⅝	10½	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	115 —117	115 —117	...	...
50,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—90,000	10	5 %	7 %	10 %	26 — 27	26 — 27	26⅝	26½
10,000	{ Do. do. Prov. Certs. Nos. 90,001 to 100,000 £5.	}10	...	...	...	19 — 20	19 — 20	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ - 18½	17½— 18½	17⅝	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 - 134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	*nil*	*nil*	*nil*	14⅝— 15½	14⅝— 15½	15½	15
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15½— 16	15½— 16	...	...
17,400	Edmundsons Elec. Corp., Ltd., ord. shares 1—17,400 ...	3	...	...	...	3¼— 3⅜	3¼— 3⅜	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	10½ - 11½	10½— 11½	...	...
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	11½ - 12½	11½— 12	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	6 %	20 — 21 xd	19½ - 20½	20¼	19½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	3 %	20½ - 21½	... — ...	...	...
220,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½ %	117 — 121	117 —121	118⅝	118
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	20 — 21	20 — 21	20 5/16	...
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½ %	18 — 19	17½— 18½	...	...
20,000	Do. do. 7 % Pref., 20,981 to 40,980	5	7 %	7 %	7 %	10 — 11	10 — 11	...	..
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	..
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2½— 2⅝	2½— 2⅝	...	...
79,900	Westminster Electric Supply Corp., Ord., 181 to 80,000 ...	5	7 %	9 %	12 %	17 — 18	16½ - 17½	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, April 5th.	Closing Quotation April 13th.	Business done during week ended April 13th, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	16 — 16½	16 — 16½	16½	16
90,000	Brush Elect. Engng. Co., Ord., 1 to 90,000...	5	2½%	*nil*	*nil*	1⅞ 2	1⅞ 2	1 13/16	1⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2¼ — 2½	2¼— 2½	2⅜	2 5/16
125,000†	Do. do. 4½ % Perp. Deb. Stock.	Stock	...	...	...	110 — 114	110 114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
19 894	Central London Railway, Ord. Shares	10	...	...	...	10¼— 10⅜	10¼— 10⅜	10⅜	10½
129,179	Do. do. do. £6 paid	10	...	...	...	6¼— 6⅜	6¼— 6⅜	...	...
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½— 2	1½— 2	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅜— 4⅞	4⅜— 4⅞	...	...
630,000†	City and South London Railway	Stock	1 1/16 %	1 1/16 %	1⅛ %	67 — 69	68 — 70	69½	69
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	1⅜ - 2½	2 — 2½	2½	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼ - 2⅜	2¼ 2⅜	...	...
17,189	Do. do. do. "A" Shares 01—017,189	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	103 —105	103 —105	...	...
110,000	Electric Construction, Ltd., 1 to 110,000		5 %	6 %	...	2⅝ 2⅞	2⅝ 2⅞	2⅝	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	5	7 %	7 %	...	3⅛ 3⅜	3⅛ 3⅜	...	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,882	2	...	...	...	1/32 3/32	1/32 - 3/32	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	3/32 5/32	3/32 5/32	...	...
9,600†	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9 — 11	9 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	22 — 23	22 23	22½	...
3,000	Do. ... do. do. 7% Pref.	10	7 %	7 %	7 %	18½ - 19½	18½ - 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½ %	110 —115	110 -115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ..	10	10 %	10 %	10 %	21 — 22	21 22	21⅜	21¼
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	1 2 —1 6	1 2 —1 6	...	...
17,500	Liverpool Overhead Railway, Ord.	10	2½%	2½%	3½ %	10⅜ 10⅝	10 11/16 10 13/16	...	...
10,000	Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15⅝ 16¼	15⅝— 16¼	...	...
77,350	Telegraph Constn. and Maintce., Ltd.	10	15 %	15 %	15 %	35 38	35 — 38	36⅜	36
150,000	Do. do. do 5 % Bonds, red. 1899	100	5 %	5 %	5 %	2 -05	102 —105	...	...
540,000†	Waterloo and City Railway, Ord. Stock	100	...	...	...	135 - 138	135 —138	137	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10½.

House-to-House Company, 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16⅝—17¼; 1st Preference Cumulative 6 %, £5 (fully paid), 8½—8⅝. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4—4½.

* T. Parker, Ltd., £10 (fully paid), 14—15.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Shar List.

Bank rate of discount 4 per cent. (April 7th 1898.)

SOCIETY OF CIVIL ENGINEERS OF FRANCE.

Sitting of February 4th, 1898.

M. Le Roy read a paper on "Electrical Heating," and first spoke of the inconveniences of the various other modes of heating (wood, coal, gas) and then proceeded to discuss the methods used up to the present day for heating by electricity. At present, heating by electricity is effected by making the electrical energy pass through fine metallic wires, offering great resistance to the current, so that these wires become heated and by conduction transmit the heat which they give off. The heat is transmitted from the wires to the insulating material that encloses them, and then to the metal surface constituting the apparatus itself, saucepan, boiler, radiator, &c. This necessitates the burner being enclosed in the apparatus itself.

For domestic purposes, therefore, it is necessary to buy quite a fresh set of kitchen utensils and train our servants to use them. From a practical point of view, these articles are, from their very construction, subject to rapid deterioration. Repairs are expensive and very difficult.

In planning his system, M. le Roy had a double object in view.

(1) To construct simple and convenient apparatus, capable for domestic purposes of being used with the ordinary kitchen utensils; saucepans, irons, &c., so that no material changes need be made.

(2) To find out theoretically what substances possess the electrical and physical properties most suited to the development of heat, and so to determine the choice of the resistance.

Of all the substances or compounds that M. le Roy has experimented upon at Prof. Troost's laboratory at the Sorbonne, crystallised silicium or graphitoid alone seems to give the desired results.

In a note, presented by M. Troost to the Académie des Sciences* at the sitting of January 17th last, M. Le Roy gave details of the resisting properties of silicium.

The coefficient of specific resistance of crystallised silicium is 1,333 times greater than that of coal used for lighting, and 235,294 times greater than that of German silver.

* See *L'Electricien*, No. 372, p. 101.

By these researches, therefore, one of the problems set was solved.

From the point of view of practical utilisation, we might construct resistances of great section and short length capable of being introduced in derivation in quantities of 1, 2, 3 or 4 into burners similar to those of gas stoves.

M. Le Roy explained in detail the theoretical considerations that served him as a basis; he concluded from them that the choice of metal for forming a resistance to be employed for heating purposes is absolutely irrational.

He then discussed the mean relative prices of the various kinds of fuel used for heating.

If we consider the various renderings of the apparatus of utilisation, the number of calories given off by each kind of heating agent would be as follows:—

Coal		1,500,000	large calories.
Gas	for rooms	1,312	„ „
	„ „	525	„ „
	„ cooking	2,100	„ „
Electricity	for rooms ...	864	„ „
	for cooking ...	777	„ „

Assuming that

The ton of coal costs	50	francs
The cubic metre of gas costs	·30	„
The kilowatt-hour costs	·25	„

The price of 1,000 large calories would be:

Coal	·033	francs
Gas for rooms	·226	„
„ „	·550	„
„ cooking	·140	„
Electricity for rooms	·289	„
for cooking	·321	„

From this it follows that, leaving aside the comparison with coal, and only establishing one with gas, which is the most important point, for the heating of rooms with the most approved gas apparatus, we shall spend 100 francs where with electricity we shall spend 120 francs, and with apparatus like the block burners, electricity will come out half as dear as gas.

Cooking at an expenditure of 100 francs worth of gas will correspond to 230 francs expended on electricity.

M. Le Roy observed that the efficiencies claimed for various gas

appliances assume that the mixture of gas and air necessary for combustion always takes place under the desired conditions: now, these conditions are rarely fulfilled in practice; according as the tap is more or less turned on, the proportions of the mixture vary and the efficiency is considerably lowered. With electrical apparatus the efficiency remains constant and does not depend on the skill of the operator.

M. le Roy then explained his system, on which two typical appliances, a heating stove and a little cooking stove, had been working since the commencement of the sitting.

This system consists essentially of the *electric block* which is constituted of a rod of pure silicium agglomerated and enclosed in a glass tube suitable for subjecting it to oxidation.

For the passage of the electric current this block is brought to a temperature of about 1,000°. The appliances for utilising the system can take any shape and any dimensions.—*L'Electricien.*

THE ELECTRICITY SUPPLY OF LONDON.*

By ARTHUR H. PREECE, Assoc.M.Inst.C.E.

The supply of electricity on a commercial scale had been started in London after the passing of the Act of Parliament in 1888, which amended the Act of 1882, principally by extending the date for compulsory sale to the local authority from 21 years to 42 years. In 1888 many companies applied for provisional orders, and, in determining which were to be granted powers, and the districts over which the powers were to extend, the Board of Trade decided that competition would be advantageous to the public, and that it was advisable to allow one direct current system to compete with one alternating current system.

There were now in London 11 important companies and five vestries supplying electricity, and three other companies and three vestries were taking steps to start works. The capital invested in the industry amounted to £6,000,000, and plant was installed to the extent of 80,000 H.P., the equivalent of 2,000,000 8-C.P. lamps being connected to the mains. The total annual revenue was £800,000, and the total annual expenditure, £450,000.

Of the systems for supplying electricity in London, the alternating current was applicable to large areas where consumers were scattered, and it enabled the generating works to be established by the riverside, or where land was cheap and coal was easily unloaded. The undertakings using this system were: the City of London Company, the Metropolitan Company, the London Electric Corporation, the County of London Company, the House-to-House Company, the Hampstead Vestry, the Islington Vestry, and the Hammersmith Vestry. The direct current systems were divisible into two classes, the high pressure and the low pressure. In the former rotary transformers were used to reduce the high pressure to a low pressure, while the latter produced and distributed electricity at the same pressure at which it was supplied to consumers. The direct current systems were applicable to compact areas, and, with the use of high pressure, to scattered or isolated compact areas. The chief advantages of the direct current system were the possibility of using storage batteries, which could not be employed with the alternating current systems, greater efficiency in distribution, and greater adaptibility to motive power. The undertakings using the system were: the Chelsea Company (high pressure), Charing Cross and Strand Corporation (high pressure), the Westminster Corporation, the St. James's and Pall Mall Company, the Kensington and Knightsbridge Company, the Notting Hill Company, the St. Pancras Vestry, and the Metropolitan Company (at one works).

The generating works of the several undertakings in London contained many interesting features. No less than 20 different works had been erected. The boilers used comprised the water-tube, marine, Lancashire, and miscellaneous types; but the preference for the water-tube boiler was very marked. The works were liable to sudden demands through fogs, and the quick steaming properties of this type of boiler were of great advantage. The boilers were fired chiefly by hand with Welsh coal, but in the works of the City of London Company and the County of London Company mechanical stokers and cheaper coal were used. The use of extensive systems of steam pipes was now being dispensed with. The multiplicity of valves was unnecessary, and the number of valves was being reduced, and arrangements were made as simple and with as few joints as possible.

The present tendency was towards engines of the marine type for large outputs. The high speed engine was not used for larger powers than 750 H.P. Some engineers, however, found engines of 350 H.P. sufficiently large and the most convenient unit to adopt. The dynamos were similar in most works, and were always connected direct to the engines. Storage by secondary batteries was not extensively employed in London, as their maintenance had hitherto proved expensive. But a few works used them entirely for maintaining the supply after midnight, and in the daytime in summer. The author gave the results of a test of a small marine engine and alternator, showing the combined efficiency to be 85·5 per cent. The question of vibration had been of great importance in many works; no cure had been found effective when once vibrations were set up. High-speed engines must have three cranks to be free from appreciable vibration.

The favourite methods of distributing electricity were to transmit current at a high pressure in heavily-insulated cables in iron pipes, and current at a low pressure in insulated cable in stoneware conduits, or in cables heavily armoured and laid direct in the ground. Rubber was now little used, paper and jute, impregnated with insulating compounds, having been extensively adopted.

The usual system of measurement of the electricity supplied was by meter, and the average charge was 5½d. per unit. The average charge in 1890 was 7½d., so that the price of electricity had been reduced in eight years no less than 25 per cent., equivalent to a reduction in the price of gas from 4s. to 3s. A curve was given to show the variations in the price of gas since 1870. The average price had varied between 4s. and 2s.; it was now 2s. 7d. The cost of generating and distributing electricity had been greatly reduced in the last few years. In 1892 it was seldom supplied for less than 4½d. per unit. The usual cost was now 2½d. to 3d. The actual cost of generating was about 1½d. per unit, and the cost of management, &c., about 1d. The direct current was everywhere produced at a cheaper rate than the alternating current. The difference was between ½d. and 1d. per unit, or 20 per cent. cheaper.

Since 1888 an important inquiry had been held by the Board of Trade regarding the maximum pressure permissible in consumers' premises. The result of this inquiry, in 1896, was to increase the pressure from 150 volts to 250 volts.

A comparison was made between the two largest companies in London, namely, the City of London Company, which supplied alternating current, and the Westminster Corporation, which supplied direct current. Both companies had nearly the same number of lamps connected to their systems, the number of 8-C.P. lamps connected being 270,898 and 269,939 respectively. The capital expended was respectively £945,829 and £546,434; the annual incomes per 8-C.P. lamp 11s. 9d. and 7s. 9d.; the annual expenditures per 8-C.P. lamp, 4s. and 3s.; and the costs per unit, 7·6d. and 5·8d.

The industry was growing so rapidly, that most undertakings had to seek new sites for generating works, and the tendency was to erect large works on the outskirts of London, where coal could be conveniently brought to the site, and where water could be obtained for condensing. The powers granted under provisional orders were limited as regards the compulsory purchase of land, and further powers were being sought by some companies from Parliament, so that they might be placed on the same footing as railway companies. No less than 40,000 H.P. was now being installed in London in order to meet the demand for electricity in the immediate future.

* Institution of Civil Engineers, London, April 5th.

SOME RECENT IMPROVEMENTS IN ACCUMULATORS AND THEIR APPLICATION TO TRACTION ON COMMON ROADS.*

By J. T. NIBLETT.

(*Continued from page* 491.)

A material for making the elements of secondary batteries quite distinct from any of those already considered is known as lithanode. The credit of devising lithanode is doubtless due to Mr. Desmond FitzGerald, whose labour in the field of electro-chemistry is well known. Batteries, with improvements made on Mr. FitzGerald's original invention, are now made by the Lithanode Electric Storage Company.

Lithanode is not compressed peroxide of lead, as is sometimes supposed, for, however strongly this lead peroxide may be compressed, the resulting mass will disintegrate when immersed in a liquid electrolyte. It is produced from litharge made into a pasty mass with a solution of sulphate of ammonia, which causes the material to "set," so that it will no longer disintegrate when placed in a fluid. The "forming," according to the original idea, was performed in a bath of sulphate of magnesia. In ordinary practice the elements are made up of a number of small slabs of lithanode, whose outer edges are V-shaped. These slabs or pellets are arranged in a casting mould of any suitable dimensions, and are placed at such a distance apart and from the edges of the casting frame as to allow of sufficient space for the requisite quantity of metal to run in and impart adequate mechanical strength to the completed element. After the pellets have been arranged in this manner, an alloy of lead and antimony is run into the interstices, and thus a complete plate is formed.

Before being cast up the positive pellets are converted into peroxide of lead in a forming bath; those for the negative plate are simply dried and cast up direct, the lithanode in the latter case being reduced to a condition of spongy lead by the ordinary electrolytic method.

Where lightness is a desideratum, as in the case of a traction cell, the pellets in the positive plates are made larger, while the negative plate is constructed of lead gauze, having its outer edge strengthened by a rim of lead. The gauze is filled in with the prepared litharge which entangles itself in the thin lead wire, and thus produces a plate of great lightness, and one little liable to fall to pieces.

Lithanode may be obtained in varying degrees of porosity. For high discharges it is made of a highly porous nature, the porosity being produced by incorporating in the material cystals of some salt, which is practically inert, and which is dissolved out during the forming operation.

The rate of discharge obtainable from lithanode batteries varies

* Abstract of paper read before the Self-Propelled Traffic Association, Liverpool Centre, on March 29th.

between very wide limits, and is regulated by the character of the lithanode, whether made hard, medium, or soft. The ordinary working rate of discharge is $\frac{1}{14}$th of an ampere per square inch of lithanode plate, but owing to recent improvements very much higher rates of discharge can be obtained.

The electrical capacity of lithanode, when discharged at the above rate, is almost exactly one ampere-hour per ounce, so that in a lithanode element weighing 1 lb. a current capacity of 16 ampere-hours is obtained. In practice, however, this high capacity is never reached.

Thinking it may be of interest I have prepared the following particulars taken from one of the company's most popular types of portable battery:—

Data of Complete 30 Ampere-hour Lithanode Batteries, including Wood Cases.

No. of cells.	Outside dimensions of battery.			Open E.M.F. of battery.	Approximate gross weight of battery.
	Length.	Width.	Height.		
	inches.	inches.	inches.	volts.	lbs.
1	3·75	7·00	6·37	2	8¼
2	5·12	7·00	6·37	4	16
3	7·27	7·37	7·00	6	22¼
4	9·50	7·37	7·00	8	29
5	11·60	7·37	7·00	10	36
6	13·75	7·37	7·00	12	43
7	15·78	7·37	7·00	14	50
8	18·00	7·37	7·00	16	56¾
9	20·12	7·37	7·00	18	63¾
10	22·24	7·37	7·00	20	70¾
11	24·36	7·37	7·00	22	77¾
12	26·50	7·37	7·00	24	84½

Detailed Particulars of Cell.

Vulcanite containing cell ... ...: 6·25 inches long; 2·12 „ wide; 5·25 „ high; weight, 10 ozs.

Positive element ...: Two plates in each cell, 5·9 inches long; 3·9 „ wide; 0·25 inch thick; weight, 1 lb. 1¾ ozs.

Negative elements...: Three plates in each cell, 5·9 inches long; 3·9 „ wide; 0·13 inch thick; weight, 11½ ozs.

Weight of connectors, 3 ozs.
Weight of cover, vent plug, sealing, and separators, 2 ozs.
Quantity of electrolyte, 15·5 fluid ozs.
Gross weight of complete cell, 6 lbs. 7 ozs.
Normal charging rate, 3 amperes.
Normal discharging rate, 3 to 4 amperes.
Maximum safe discharging rate, 9 to 12 amperes.
Approximate internal resistance, 0·015 ohm.

The data given will give a fair idea of what is obtained in actual working with this form of cell. Other batteries of larger capacity are, of course, made, and as the capacity increases, the proportional weight and bulk slightly decreases. These batteries have been used extensively for lighting vehicles, actuating coils for X ray photography, and for propelling electric launches and light forms of motor-cars.

The Chloride Electrical Storage Syndicate make their accumulator plates on a somewhat similar plan to that adopted by the Lithanode Company. In this case, however, instead of using litharge, chloride of lead is employed to make the pellets.

Chloride cells are well known and largely used for traction purposes in America, and they are very well received in this country also.

A form of cell which is just now exciting much attention on the Continent is known as the "Marschner" cell. The Marschner battery is at present being used on the Dresden tramways, and it is said to be behaving in a very satisfactory manner. The plates are stated to consist of the ordinary oxides of lead, incorporated with powdered amber and an essential oil. This mixture is said to "set" very hard, the resultant plate being of a tough metal-like nature. On the Dresden car 144 cells of this type are being used. Each cell contains 13 plates, and is said to weigh only about 28 lbs. The weight of the complete battery is given as 5,290 lbs. Its efficiency is stated to be over 90 per cent., and if discharged at its normal rate—that is, 65 amperes—an energy capacity of 13 watt-hours per pound of cell is obtained.

When devising cells for traction purposes many difficulties have to be overcome. Owing to their high initial cost, a small number of cells should be made to suffice, and these should be so constructed that they will run a vehicle for a reasonable number of hours with one charge. They should be capable of being charged and discharged at rapid rates. Above all, they should be able to withstand the jolting and jarring incidental to their being run over rough and uneven roads. The cell should be so constructed that the wash of the electrolyte does not remove the active material.

There is at the present moment an enormous field for an inexpensive cell which will combine large capacity with small weight and great solidity. Some form of mechanically solid cell seems to offer the best solution for this problem. Some little time ago great hopes were entertained that the solidity problem had been solved by the introduction of Dr. Schoop's solid electrolyte. This so-called solid electrolyte was made by adding silicate of soda to the ordinary solution, which caused it to set and become of a gelatinous nature. In this country some practical tests have been made with Mr. Barber-Starkey's method of making solid cells by substituting for the electrolyte a mixture of wood sawdust and plaster of Paris, which when set was moistened with dilute sulphuric acid.

The accumulator known in America as the "Hatch" is of a mechanically solid nature. In this case metallic frames are not employed for supporting the lead salts, as they are held within a porous earthenware grid serrated on one side, and, having small square recesses on the other. Plain lead plates are used as conductors, and these are bedded on the moist lead salts. According to this arrangement there is no clear liquid space between the elements, as the serrated earthenware plates touch one another, and are so placed that the ridges on one plate are placed at right angles to those on the other. Wooden clamping plates with India-rubber bands placed around them are fixed on the outside of each end element, and these serve to give the requisite elasticity. The "Pumpelly" cell is another American production, and in this case the mechanical solidity of the cell is arrived at by inserting plain, thick, porous earthenware plates between the elements. In this case, however, the plates are placed horizontally instead of vertically as in the "Hatch."

One great drawback to the employment of a viscous, gelatinous, or semi-solid electrolyte arises from the fact that when such substances are interposed between the plates no free circulation of the liquid is possible. In all secondary batteries, as already shown, the activity of the elements depends entirely upon chemical action, and as the electrolyte is a medium through which all these reactions occur, it seems highly probable that anything which prevents its free access to the active material, or in any way impedes its circulation, must be detrimental, and consequently lead to loss of efficiency and capacity.

Some few years ago, having in view the advantages likely to be derived from the employment of a mechanically solid cell, for traction purposes, the author gave some attention to this particular form of battery, and a number of cells were constructed having this object in view. In most cases the elements consisted of a highly cellular mass of active material which was capable of absorbing a sufficient quantity of electrolyte for the due performance of all the necessary chemical actions. Between each mass of active material was inserted a thin, highly porous, inert diaphragm, which was not found to materially increase the internal resistance, and served to complete the solid character of the cell. A large number of different combinations with various kinds of active material were tried. Owing to the cellular nature of these elements the liquid contained in the mass continually circulated, the slight evolution of gas which occurred during both the charging and discharging operations being quite sufficient to affect this. The active material was in all cases so placed that it could not be dislodged. It was found that the cellular character of the electrodes gave them a peculiar power of regulating their own internal resistance: for if the cell was being charged at too high a rate, or when it was on the point of being fully charged, the gas generated tended to drive the liquid out of the pores of the electrodes and remained imprisoned therein, thereby greatly increasing the resistance and stopping the flow of current. On the discharge, the occluded gas appeared to re-enter into the chemical combination and allow the liquid to refill the pores, thereby exposing more active surface. Little or no commercial use was made of this plan of construction, as at the time the author's attention was diverted into other channels, and the matter was dropped.

(To be continued.)

REVIEWS.

The Engineers' Year-Book, 1898. By H. R. Kempe, A.M.I.C.E. London: Crosby, Lockwood & Co., 1898.

This valuable office book of reference has reached its fifth year, and has fairly kept to its original intention—that of keeping with the times—the various formulæ and descriptions being overhauled from year to year, so as to keep the book up-to-date.

In this year's section new matter has been added to the Earthwork Tables, and to that of Railways in respect of "Crossings," and the abstract of the Board of Trade regulations, which have been carried out by Mr. C. Seymour, of the Midland Great Western of Ireland. Information on gas engines has been supplied by Mr. H. Scholey, the section being entirely re-written. It is now in better form than before, but may still be desirably extended by illustrations and descriptions of other gas producers, and, we think, fuller reference might be made to the Thwaite system of blast furnace gas utilisation, a system which is bound to come to the front. Numerous other additions have been made, and the book contains 850 illustrations and nearly 700 pages of letterpress and index. We are inclined to think that much space might be saved by reducing some of the tables to

smaller print. For example, there is a very extended table of specific gravities. It might be reduced by two pages, or even more, if many of the articles were taken out of it. This table is very full, but the equally important table of specific heats is paltry in the extreme. We required to use this, and failed to find the specific heat of glycerine, but we could find the specific gravity of juniper wood. We never knew of anyone who ever needed to know this. Juniper berries are used to flavour gin, but of what special use is the wood? Further additions might be made in the notes on water softening, which are very scanty.

We should like also to see a little fuller information on fuels. We find no statement of the calorific capacity in B.T.U. of any fuels solid or gaseous, but only of liquid fuels. More might now be given as to liquid fuels, say, an illustration of one or two examples of liquid fuel application to boilers, rivet furnaces, &c. Who knows, for example, that when using liquid fuel, it will not be practicable to mix tar with petroleum with any idea of thinning the mixture and increasing its fluidity. The petroleum will simply draw out the more liquid portion of the tar and send the pitch to the bottom to the choking of valves and pipes.

There is no information on coke ovens or residuals recovery plant—both of some engineering importance. The *fan* section might be extended and so also the pump section, two special varieties of which we see are omitted—the Hamilton and the Pohlè. We note an error in the formula for radial axle boxes. The expression to the right of the = should have a denominator 2, the true formula being—

$$x = \left[\frac{(a+b) - \frac{a^2}{a+b}}{2}\right]$$

Makers of radial axle box vehicles have been lax in their proportioning, and this accounts for the bad running and unpopularity of radial boxes. The formula is due to Mr. Baldry who was once in the office of Sir John Fowler and, we believe, worked out the proportion of the radius bar for the eight-wheeled passenger carriages sent out under Sir John—then Mr.—Fowler's directions to New South Wales.

In sewage treatment there should be something given on the new system of bacteriological treatment which appears likely, as far as present indications point, to prove successful.

In pointing out these items, we would not imply that we look on their omission as serious, but they are items which may well be included in the next edition.

Magnets and Electric Currents. By J. A. Fleming, M.A., D.Sc., F.R.S. London: E. & F. N. Spon, Limited, 1898.

This is described as "an elementary treatise for the use of electrical artisans and science teachers." The scientific knowledge of the reader is assumed to be practically *nil*, and the subject is taken up from the very beginning.

"Electrical artisans" of average intelligence who have scientific tendencies will undoubtedly find much to interest them in the author's admirable and lucid descriptions of how to make various pieces of electrical apparatus, from the simplest primary battery to the most perfect reflecting galvanometer, with things found about the house; and if they will only put such pieces of apparatus to the uses for which they are intended, and at the same time devote their attention to some of the less fascinating passages in the book, they will most certainly tend to become more useful members of the electrical community.

With regard to science teachers, these are of various kinds. Dr. Fleming is probably addressing himself to those whose teachings are intended to be of use to the electrical artisan, and not to the more familiar class of teachers whose teachings produce teachers.

From the reviewer's point of view, the preface is one of the most interesting portions of this substantial volume of 400 pages, because it gives him some assistance in discovering the lines upon which the author's mind has been working.

Dr. Fleming is a staunch supporter of Mr. Heaviside in his determined endeavours to eliminate, at all costs, the noxious multiplier 4π from a large number of magnetic formulæ. He is also passionately fond of words, apparently for their own sake, and he cannot resist the temptation of giving names to things, even to mere ratios and multipliers, quite apart from the question as to whether these latter have a physical meaning or not.

We all use the word "voltage"; it is a word which was wanted, and for this reason it came—quite of its own accord; it was never invented. But Dr. Fleming now suggests *voltivity* for "voltage per centimetre." *Amperage* is also a word he enjoys writing, and when he gets to *gaussage* and *gaussivity* he is really happy. All this we can stand, within limits; but when he suggests *fluxage*, we think he is going a step too far. "Flux" was good enough for us in *our* young days, and the word is only a makeshift in any case. Then there is *coercivity*, which is not wanted, and *retentivity*, about which there is something aggressive which annoys us.

We do not say of a dinner plate that it possesses a property called greasic retentivity or greasivity, simply because, when insufficiently washed, it may retain traces of the food which has been placed upon it: there is, perhaps, no valid reason why we should not use such expressions; but, on the other hand, there is no necessity for them; and although it is well for the electrical artisan to know what is meant by residual magnetisation, he does not require to be told that it is the result of a certain quality of the iron called magnetic retentivity.

There are many other expressions which the electrician of the old school will assimilate with difficulty: thus, on page 127, is a table giving the "resistivity" of metals in "microhms per cubic centimetre," which is equivalent to what we have known for many years as the specific resistance in microhms per centimetre cube.

Returning to the preface, the author, after introducing a host of new names, remarks with reference to Faraday's beautiful conception of "lines" or "tubes" of force (which has never failed as yet), that the practical student would benefit by discarding such notions, and thinking only of a "physical state existing in a magnetic circuit, which is measured in webers and microwebers," the active cause of which is called *gaussage*, and the thing itself *fluxage*. Is he sure of this, or is it not possible that he may be mistaken, and that the practical student, of all people, is the one to whom it is essential that he should be allowed to *picture* in his mind these same magnetic lines or tubes, which have to be *cut* by a conductor in order that the latter may have an E.M.F. generated in it? It is to be feared that, however much the said practical student may *think* of a physical state (called *fluxage*), this will not lead him to great things unless he be a born mathematician.

Dr. Fleming is to be congratulated upon having abandoned much that is old-fashioned in his treatment of the subject of magnetism; the strength of field is, however, still occasionally considered in relation to the tendency which would be experienced by a free magnetic pole (if let loose) to travel down it; and there are references to the demagnetising forces exerted by the poles of a magnet, which do not fit in well with the more modern conceptions of the magnetic circuit.

The last few pages of Chapter III. deal with Mr. Heaviside and the "disfiguring" 4π. A list of Mr. Heaviside's suggested units expressed in terms of the present C.G.S. units is given, and the advantages of the new system (which are undoubtedly well worthy of consideration) are pointed out; but it is to be feared that the average Englishman will resist any attempt to change his present electrical units, for the same reasons which induce him to resent the mere suggestion of altering his delightful system of weights and measures.

In Chapter II. the author generalises on the subjects of matter and energy, space, time, and force, and describes the C.G.S. and other systems of units; and in Chapter V. he takes up a certain amount of more or less valuable space by giving us the legal definition of the ohm, ampere and volt, accompanied by all the customary rigmarole, beginning "Whereas," and ending with Her Majesty's expressions of pleasure in approving the "several denominations of standards set forth in the schedule hereto appended." Chapter VI. deals with electro-magnetic induction, and Chapter VII. is devoted to electro-magnets. The relation between the directions of the magnetic flux and induced E.M.F. is stated in various ways, but not always successfully. For instance, the "practical" student who is told to thrust his arm through an imaginary ring and give it a *positive*

twist by rotating his hand in a *counter*-clockwise direction, may be expected to smile, and refuse to do it.

What is meant by mutual induction, or mutual inductance as Dr. Fleming calls it, is not made sufficiently clear. What the student generally does not understand is, where the *mutuality* comes in, and this is not explained.

In Chapter VIII., which deals with alternating currents, the much abused word "inductance" plays an important part. Dr. Fleming uses it to denote (as is customary nowadays) the quantity which is better known as the coefficient of self-induction; but it is a word with a considerable amount of latitude, and as used in many instances it would appear to be synonymous with what, towards the end of the chapter, is called the *reactance*.

Consulting engineers should read the section on transformers with the utmost caution, in order that they may not come upon the following sentence too suddenly:—"The transformer must have cooling surface enough to dissipate all the core losses without rising above the temperature of boiling water." They will do well to give this idea time to soak in, and who knows but what some of them may, in the future, have the sense to leave questions of temperature rise to the manufacturer. It is true that Dr. Fleming appears to have been carried away by a slight excess of common sense; but he shows a total and fearless disregard of public opinion which is highly commendable.

The last two chapters deal respectively with electric measuring instruments and the generation of electric currents. On page 295 is a table giving the safe working currents which may be carried by Hadfield's *resista* wire, and on the following page, a similar table for German silver wire. The temperature of the wires is, in each case, supposed to be such as "can be easily borne by the hand." It is, therefore, interesting to note that, in some of the smaller sizes, the safe current for the *resista* wire is three times as great as that given for German silver; and as the conductivity of the latter metal is four times as great as that of resista metal, it follows that, for the same amount of cooling surface, and approximately the same temperature rise, the watts lost in the one case will be 36 times greater than in the other.

Having picked out, and sufficiently magnified a few of the weak points in this book, it is only fair to add that, as a whole, it has much to recommend it. The author has done his best to treat each subject in as clear and simple a manner as possible, and he is to be congratulated upon the admirable way in which he has accomplished an exceedingly difficult task.

PERIODIC CURRENTS.

By W. G. RHODES, M.Sc.

THE tendency of late years has been to forsake the old methods of conducting alternating current calculations and to reduce the difficulties to the physical conceptions of the various phenomena. Formerly, no student not well equipped with a first rate mathematical training could hope to read intelligently the then existing literature on this subject. It was not until the application of graphical methods by Mr. Blakesley that alternating currents came at all within the scope of the ordinary electrical reader. Many writers followed suit, and nearly all writings teemed with diagrams, very interesting and useful to readers, but apparently demanding an altogether outrageous expenditure of mental energy on the part of the original writer. Who can look at the writings of Bedell and Crehore, Blondell and others, without being struck with the idea that the graphical representations of the currents and E.M.Fs., their magnitudes and phase relationships in multiple circuits and combination of circuits, must have required an altogether exorbitant amount of mental effort? That this feeling is becoming universal is evident from the fact that nearly all the prominent writers on alternating currents now use methods which, while of an analytical nature themselves, are easily capable of graphical interpretation and representation. All these methods depend upon the fact that the electrical quantities considered are capable of being represented by lines drawn of suitable lengths and along proper directions relative to each other, and upon the ability to represent algebraically directions of lines relative to one another by the help of the imaginary $\sqrt{-1}$.

Steinmetz, with the method of the complex variable, has materially advanced our knowledge of induction machines, and has carried the subject probably further than would be possible with the aid of graphics alone.

M. Vaschy has recently noticed that on the assumption that alternating electromotive forces and currents can be represented by simple sine functions of the time, if e is any such periodic function, then $\frac{d e}{d t}$ may be replaced by its geometrical equivalent, $p e \sqrt{-1}$, where $p = 2 \pi n$, and n is the frequency of the function in question.

In the *Annales Télégraphiques* for November—December, 1897, M. Pomey draws attention to the writings of Vaschy, and shows how, for instance, the transformer equations

$$\left.\begin{aligned} L_1 \frac{d i_1}{d t} + M \frac{d i_2}{d t} + r_1 i_1 &= e \sin p t \\ L_2 \frac{d i_2}{d t} + M \frac{d i_1}{d t} + r_2 i_2 &= 0. \end{aligned}\right\} \quad (1)$$

where L_1, L_2 are coefficients of self-induction; M, that of mutual induction; r_1, r_2, resistances; i_1, i_2, currents; and $e \sin p t$, the applied E.M F. are geometrically equivalent to the equations

$$\left.\begin{aligned} p L_1 i_1 \sqrt{-1} + p M i_2 \sqrt{-1} + r_1 i_1 &= e \\ p L_2 i_2 \sqrt{-1} + p M i_1 \sqrt{-1} + r_1 i_2 &= 0. \end{aligned}\right\} \quad (2)$$

It should, however, be particularly noted that equations (1) are more general than equations (2). The complete solution of (1) gives the values of the currents for all time subsequent to the *instant of closing the primary circuit*, whereas from equations (1) only the steady values of the currents can be obtained. Further, equations (1) are perfectly general whatever be the nature of the applied E.M.F., but for equations (2) to hold good both the applied E.M.F. and the currents must be capable of representation as a simple sine function of the time.

The writer has recently shown in a short series of articles* the application of a method leading to equations of a type similar to (2), which is essentially a vector equation of E.M.Fs. It is further demonstrated that vector equations can only exist between E.M.Fs. so as to form a vector E.M.F. equation, or between currents forming a vector current equation. It is seen that by the combined aid of analysis and graphics, problems which are otherwise formidable are solved with ease, and the analysis itself only demands quite an elementary mathematical knowledge. It is of great value that any step in the process should be capable of being readily represented in a graphical form, thus enabling a better physical conception of the problem to be obtained.

It is with no hesitation that I say that vector algebra, or allied processes, must eventually—and that before long—form the basis of calculation for all *useful* text books on alternating current phenomena, and that it is to the application of these methods we must chiefly look for further advances in the theory of the subject.

THE TRAMWAYS INSTITUTE.

THE end of March or the beginning of April might fairly be considered rather a late period at which to issue a publication bearing date of *January*, and on receipt of the *Tramways Institute Journal* the other day, we could not quite understand the belatedness of the copy sent us, except on the supposition that copies are sent out in a leisurely fashion.

The January issue, however, contains plenty of February news, so that the Institute, and its officials responsible for the journal, are not quite so out of date as would appear on the surface.

When the tramway interests of this country are strong enough, or rich enough, or united enough to support a

* "The Application of Vector Algebra to Alternating Currents," by W. G. Rhodes, M.Sc., ELECTRICAL REVIEW, January 7th, 14th, and 21st, 1898.

flourishing Institute, with an editor on the premises, this journal (if it survive so long) may then, perhaps, serve as a suitable record of proceedings; but in its present form it hardly justifies any existence at all, in view of the excellent appearance given by the electrical and railway journals that make a special feature of tramways and things appertaining thereto.

The advertisement pages of this journal afford very interesting and instructive matter for thought. Varnishes, metal for bearings, tramcars, tickets, ticket punches, rails and paving materials—all these are in order, and will probably be required even when *all* our lines are worked by electricity; but what is to be said in this present year of grace of advertisements in a tramway publication dealing with the advantages of antiseptic ointment and other medicines for horses, patent steel whipple trees, fodder of all kinds, chaff cutters and similar machines, harness, and horse rugs?

We should have thought that the benefits of advertising such materials in a *tramway* paper would not be very excessive, so far as future orders are concerned.

True, we find a few counteracting notices of electric tramway contractors and manufacturers of plant: but they don't wear a happy look in such company. The whole publication, in regard to advertisements, has the appearance of the American street railway journals of many years ago.

Turning to the inside pages, the electric car has there a field all to itself; the horse is ignored, and cables only mentioned once or twice.

Although, as stated, some of the items in the letterpress are rather more recent than the date on the outside cover would appear to convey, yet we cannot say very much for the contents. It is, and must be, extremely difficult to give *news* in a publication that appears once a quarter or so, and then three months behind time; but on the other hand, a complete summary of the quarter's proceedings—which alone would otherwise be worth consideration—would entail great labour on the part of an editor (who should have special knowledge and experience), whilst the resulting publication to be of service, would have a much greater bulk than that now before us.

However, we would not wish to detract from any efforts to encourage electric traction, and therefore welcome the evident desire of the Tramways Institute to deal more with this subject than in time past has been the case.

THE PREPARATION OF COPPER SAMPLES FOR CONDUCTIVITY TESTS.*

By Dr. S. SHELDON, Polytechnic Inst., Brooklyn.

While the electrical fraternity is interested with the subject of standardisation of electrical apparatus I should like to call attention to the necessity of adopting a standard condition of softness for samples of copper whose conductivity is to be tested. Of course, users of copper wire are interested in the conductivity of the wire in the condition in which it is furnished to them—not in the conductivity which might have been given to the wire, if it had been treated differently. While the copper losses in most electrical machinery are but a small percentage of the output, and while the temperature at which the machinery will operate is uncertain, owing to the uncertainty of the factors entering into the heat escape, still in many cases a reduction of the copper losses by a few per cent. is worth struggling after. The determination of the conductivity of wire used for such purposes is an easy matter. On the other hand, the requirement of a definite conductivity, frequently found in specifications for construction work, where rubber-covered or similar wire is to be employed, gives no opportunity for the verification of the fact that the requirements of the specifications have been complied with. It is impossible to determine the cross section of the wire and the value given by the manufacturer must be accepted. Again, the tinning of the wire makes the resistance measurement valueless. These difficulties are met in some cases by the purchasers sending inspectors to the factories to determine the conductivity before the wire is covered. This is, perhaps, the best solution of the problem under the circumstances, and, according to Abbott, is the practice in American aerial line construction. To electrolytic copper refiners and all buyers and sellers of bulk copper for electrical purposes, a standard method of treatment of test samples is of utmost importance. Cases have been known where copper, contracted for future delivery at a certain price, has been rejected at the time of delivery because of too low a conductivity, the ruling price at the time of delivery being less than at the time of making the contract.

The American Institute of Electrical Engineers has adopted as its standard of conductivity for copper the value given by Matthiessen for soft copper. This is contrary to the original advice of the Committee on a Standard Wiring Table, and resulted from statements made in the discussion of the report that there were many degrees of hardness, implying that a soft condition was easily obtainable, and could be reproduced. To ascertain whether this were true or not, I had two students of last year's class at the Institute, Messrs. Alfred Muller and Herman Wallatt, investigate the influence of softness upon the conductivity. A sample of wire was passed several times through holes in a drawplate in such a manner as to yield a very hard wire. This wire was cut up into separate lengths. The assumption was made that the resistivities of these lengths were equal. The lengths were then separately subjected to different annealing temperatures for a fixed interval of time, the sample, in one set of experiments, being placed in a vacuum, and, in another set, in hydrogen. The different temperatures were produced by sending different currents through the samples. The temperatures were calculated from current measurements and measurements of voltage between separate potential terminals on the samples, Kennelly's temperature coefficient being assumed as correct. After treatment, the conductivities of the samples were calculated from measurements of resistance, length, weight, and specific gravity. The results obtained for samples annealed in a vacuum are given in the following table:—

Number of sample.	Annealing temperature.	Per cent. conductivity.
1	20°	101·5
2	37°	101·5
3	54°	101·5
4	118°	101·6
5	215°	102·0
6	300°	102·1
7	600°	102·4
8	755°	102·7
9	930°	99·0

The results for samples which were annealed in hydrogen are given in the following table:—

Number of sample.	Annealing temperature.	Per cent. conductivity.
10	20°	99·0
11	45°	99·0
12	105°	99·3
13	234°	99·8
14	360°	101·0
15	483°	101·9
16	1,050°	89·3

One end of sample 16 melted after annealing current had been flowing for about a minute. A sufficiently long wire remained for the conductivity test. This sample was very soft, and had lost much of its tensile strength.

These results show that annealing to a softness, which shall give a maximum conductivity, must take place at a high temperature regulated within rather narrow limits. The maximum mechanical softness would be obtained if the sample were melted, and, after being cast in a graphite mould, were allowed to cool off slowly. Very smooth filiform samples can be obtained in this manner. But the conductivity of copper is so dependent on the amount of sub-oxide of copper which is present in it, and this amount is altered to such an extent by melting, that the conductivity determinations on such samples give no indications of the electrical properties of the original samples. As has been recently stated by Swan, the electrical conductivity of electrolytic

* New York *Electrical Engineer*.

copper is reduced by more than 1 per cent. by melting and casting into the form of wire bars. It would, therefore, appear to be better to subject all samples to the hard drawing process. Conductivity tests would then properly indicate the original electrical quality of the copper.

COMPARATIVE COST OF STEAM AND ELECTRIC POWER.

IV.

In continuation of Mr. Taylor's articles, the water and fuel costs are elaborately tabulated, the steam consumption being found by Prof. R. C. Carpenter's method. We need not repeat the voluminous figures for the different cases, but merely summarise the results under the head of total cost for each case of 10, 25, 50, and 100 H.P., with coal at 8s. and 16s. per ton.

Coal at 8s.

	10 H.P.	25 H.P.	50 H.P.	100 H.P.
	d	d.	d.	d.
Case I.				
Cost per H.P.-hour. Coal at 8s.	2·16	1·5	1·07	1·4
Coal at 16s.	2·46	1·73	1·27	1·07
Case II.				
Coal at 8s.	4·09	2·67	1·93	1·45
Coal at 16s.	4·59	3·05	2·24	1·70
Case III.				
Coal at 8s.	10	6·36	4·52	3·29
Coal at 16s.	11·02	7·14	5·11	3·78

Considering now the cost of electric power, the point of comparison is made at the point of delivery of brake horse-power.

The same elaboration of detail is gone through, which we cannot follow; sufficient that the results are given as below:—

H.P. of plant.	Description.	Cost of power. Pence per B.H.P. hour. Load factor 1.	Load factor ·46.	Load factor ·18.
10	Electric motors ...	1·95	3·45	5·01
	Engines, coal at 16s.	2·46	4·59	11·02
	" " 8s.	2·16	4·09	10·0
25	Electric motors ...	1·79	2·03	3·99
	Engines, coal at 16s.	1·74	3·05	7·14
	" " 8s.	1·50	2·66	6·36
50	Electric motors ...	1·73	1·93	2·46
	Engines, coal at 16s.	1·27	2·23	5·11
	" " 8s.	1·07	1·93	4·52
100	Electric motors ...	1·70	1·89	2·44
	Engines, coal at 16s.	1·07	1·70	3·78
	" " 8s.	1·40	1·45	3·29

We give the above for what they are worth: the author has spent an enormous amount of labour on his calculations. The difficulty of all such estimates comes in with other items apart from the power plant in use. We think it difficult to work out the matter as Mr. Taylor has attempted. Yet, an experienced engineer, with little electrical knowledge, would walk through a works, note the general appointment of the power plant and of the existing modes of transmission, and make a shrewd guess at the desirableness, or otherwise, of changing the motive power. The actual question will very frequently lie between the inside manufacture of electricity and its transmission through the works and its purchase from outside supply companies.

Too frequently it will be a question as to the particular supply company one may be on. The calculations for the City of London Company, or for the County of London Company, to take two extreme cases, would obviously show an enormous difference.

NEW METHOD OF MEASURING THE INTENSITY OF MAGNETIC FIELDS.*

By E. BOUTY.

I have recourse to the induction, reciprocal of that employed by M. Lippmann in his mercurial galvanometer. A liquid conductor, which may be simply river water, flows at right angles to the field to be measured. The constant electromotive force induced between two opposite faces of the stream is determined by means of a capillary electrometer; whence, knowing the flow, we can deduce the intensity of the field. To take a simple case, suppose the velocity of the flow, v, to be uniform over the whole section of a rectangular stream of depth, e, measured in the direction of the lines of force, and of width, l, measured in a direction perpendicular both to the lines of force, and to the stream. The induced electromotive force is constant, and has a value E,

where $$E = H v l. \quad (1)$$

The flow is $$D = v e l. \quad (2)$$

Whence $$H = \frac{E e}{D}. \quad (3)$$

We have to apply this very simple formula.

Equation (1) shows that the induced electromotive force is independent of the nature of the liquid conductor. I employed at first solutions of sulphate of copper, both saturated and very dilute, flowing through a rectangular conduit or tube of ebonite. Two electrodes of copper ·01 metre long, and of a width, e, exactly occupy the side surfaces of the tube between the back and front faces of the stream. Having ascertained that the electromotive force measured is perfectly independent of the concentration of the solution, I was able, without making any other change, to substitute water from a tap for the sulphate of copper: the facility of making measurements remaining the same. Polarisation of the electrodes introduces no disturbance.

Using water as the liquid conductor, high velocities of flow can be employed, and the sensitiveness of the method indefinitely increased.† With velocities varying from ·5 metre to 17 metres per second, I have proved that the electromotive force is exactly proportional to the speed, and have detected fields of the order ·5 C.G.S. unit. I see no reason to think that I have reached the limit of possible sensitiveness.

For comparative measurements neither the depth, e, of the tube nor the rate of flow, if it be kept constant, need be measured, and the tube may have any convenient form; but perfect insulation of the electrodes is absolutely necessary. For absolute measurements, a standard tube must be procured in which e is of such a size that the value of v may be treated as sensibly uniform over its sectional area, as we have supposed to be the case in the equations.

The copper electrodes of width, e, the depth of the tube, must be inserted into the walls so far from the inflow‡ that the velocity of the stream may be uniform over the area between them. Moreover, a correcting coefficient is required, differing however but little from unity, for the reduction of speed near the walls of the tube. For tubes from 1 to 6 millimetres deep, I find an expression $e + ·13$ mm., representing the effective depth, may be substituted for e in equation (3).

Since the electromotive forces measured with different conduits are rigorously proportional to the field and to the stream velocity, one may determine by comparison with a standard tube the effective depth of any other tube, which may be extremely shallow, and afterwards use the latter as a secondary standard.

In cases where the electrometer is inconveniently sensitive, a large condenser, say of 2 or 3 microfarads, may be charged by the induced electromotive force and discharged through a ballistic galvanometer. Fields of 50 C.G.S. units may be readily recognised in this way.

I have already used my method in the study of the curves of saturation, and of residual magnetisation of electro-magnets, and propose to apply it in other ways.

* Translation of a note presented to the French Academy of Sciences, January 17th, 1898.

† It is only limited practically by the maximum stream at one's disposal.

‡ Five cm. at least for a tube of 5 mm. in depth.

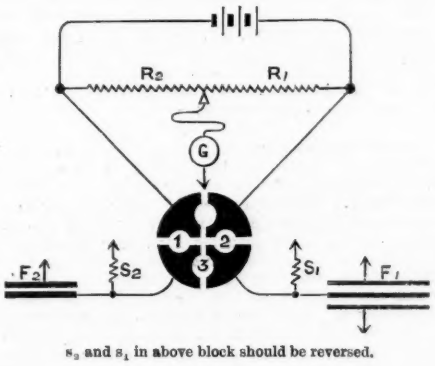
NOTE ON CONDENSER SHUNTS.

By E. RAYMOND-BARKER.

Messrs. H. K. C. Fisher and J. C. H. Darby, of the "Eastern Extension" Cable Company's staff, have lately brought out a book entitled "Students' Guide to Submarine Cable Testing."

There is one matter which might, with advantage, have received some attention from the authors of this admirable and very practical treatise. This matter relates to capacity tests on long cables in connection with the rule first suggested by "F. W.," of Alexandria, in the *Electrician* of February 5th, 1892, namely, that if the dielectric resistances of cable and condenser be in inverse ratio of the respective capacities, a dead-beat Thomson or Gott balance can be obtained without any attendant necessity for correction for difference in absorption.

This means, in other words, that cable and condenser, either one, or both, must, for the rule to apply, be so shunted that the dielectric resistance (D R) *per microfarad* be the same in both the inductive systems.



S_2 and S_1 in above block should be reversed.

A moment's thought shows the correctness of this rule, and one or two illustrative examples in this connection may not be amiss in this "Note."

A pretty exemplification, by the way, of the above rule is the practice, adopted when feasible, of using a real cable of comparatively short length, and therefore easily standardised, as a standard against which to compare a much longer cable, the capacity of which is required to be known as a check on factory values for, let us say, final tests after the laying of a cable. Where this device is practicable, and the cores are of similar material, and of like characteristics in regard to D R and capacity, a Thomson capacity test requires no correction.

This simplification becomes all the more certain in effect if attention be paid to the law enunciated for the first time by Messrs. Fisher and Darby in their afore-mentioned treatise, viz.,

Time of charge = K R *seconds*.

where K = total capacity of cable in *farads*.

R = total conductor resistance in ohms.

Since the D R of a given core varies directly, and its capacity inversely as log $\frac{D}{d}$, the D R of any given core clearly varies inversely as its capacity, and where, after a correct time of charge, this relationship exists on both sides of a Thomson or Gott capacity balance, the expression $\frac{F_1}{F_2} = \frac{R_2}{R_1}$ holds good without need of correction.

A slight fault in either cable, in the above-mentioned example, or a decided difference in the D R characteristics in the gutta-percha used in the two cables, would necessitate application of the shunting principle. Much more would this be so when a cable of comparatively low D R per microfarad is balanced against a standardised paraffin-paper condenser of very high D R per microfarad.

The following is a practical example:—

F_2 = capacity of standardised condenser = 100 microfarads.

F_1 = known approximate capacity of cable = 750 microfarads.

I_1 = total D R of cable = 7·2 Ω.

I_2 = D R to which standardised condenser with a total D R of 315 Ω (I_3) has to be reduced in order to be proportionate to I_1 inversely as the respective capacities.

$$\frac{I_2}{I_1} = \frac{F_1}{F_2}.$$

So $$I_2 = \frac{F_1}{F_2} I_1 = \frac{750}{100} \times 7{\cdot}2 = 54\ \Omega.$$

What then will be resistance of shunt S_1 which, applied to I_3 of 315 Ω, will reduce D R to 54 Ω?

It is clear that $$I_2 = \frac{I_3 S_1}{I_3 + S_1},$$

from which $$S_1 = \frac{I_3 I_2}{I_3 - I_2} = \frac{315 \times 54}{315 - 54} = 65\ \Omega,$$

the application of which resistance between the condenser terminals equalises the respective D R's per microfarad, viz.:

Condenser:—54 × 100 Ω microfarads = 5,400 Ω per microfarad.

Cable:—7·2 × 750 Ω microfarads = 5,400 Ω per microfarad.

The shunt of 65 Ω may be found inconveniently high; the plan may, therefore, be adopted of shunting the cable down to, say, 1 Ω (I_4), the condenser shunt being then readjusted to suit new conditions.

I_1 of 7·2 Ω to be reduced to I_4 of 1 Ω must be shunted by

$$S_2 = \frac{I_1 I_4}{I_1 - I_4} = \frac{7{\cdot}2 \times 1}{7{\cdot}2 - 1} = 1{\cdot}16\ \Omega,$$

which may be distributed in two leaks, each of 1·16 × 2 = 2·32 Ω, one at each end of the cable.

Resistance I_2 to which I_3 of 315 Ω has, under the new conditions, to be reduced

$$= I_2 = \frac{F_1}{F_2} I_4 = \frac{750}{100} \times 1 = 7{\cdot}5\ \Omega,$$

and for this effect to be produced I_3 has to be shunted by

$$S_1 = \frac{315 \times 7{\cdot}5}{315 - 7{\cdot}5} = 7\ 68\ \Omega.$$

The respective D R's per microfarad have now become:—

Condenser:—7·5 × 100 Ω = 750 Ω per microfarad.

Cable:—1 Ω × 750 = 750 Ω per microfarad.

By means of glass tubes of distilled water with non-oxidisable terminal wires, high resistance shunts are easily extemporised and adjusted.

Distilled water in a tube of 50 mils. (approx.) interior diameter was found to give 4·13 Ω per inch of tube against an approximate 0·21 Ω per inch for tap water, both at 60° Fah.

With glass tubing bent under heat into a compressed helix with non-oxidisable contact wires introduced at short intervals, a convenient and compact adjustable high resistance may be devised.

Other liquids of greater or less resistance may be used as circumstances suggest. Under certain conditions, plumbago or lead pencil lines of various thicknesses on a smooth but unpolished ebonite surface prove of service, but liquid resistances show a steadier constancy.

Anent the Thomson capacity test, Messrs. Fisher and Darby remark that it is omitted from their book as the test requires a special key. The above diagram shows how an ordinary quadrant pole-reverser may be used: 1 and 2 being plugged for charge, and 3 for mixing. The best key for this test is the Silvertown mixing key designed by Mr. W. A. Price. It is, electrically, the same as the Lambert mixing key, but enjoys the advantage of good rubbing contacts, and extreme simplicity in construction.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

7,398. "Improvements in dynamical machines." F. Stolze. Dated March 28th.

7,408. "A new or improved electricity meter." W. Holmes. Dated March 28th.

7,423. "Process for the extraction of pure metals or metallic alloys and carbides by electric heat." H. Aschermann. Dated March 28th. (*Complete.*)

7,450. "An underground electric current delivery for street railways." H. Daniel. Dated March 28th. (*Complete.*)

7,455. "Improved method of making the active mass in accumulators." F. Frentzel. Dated March 28th.

7,467. "Improved means applicable for use in operating electrically illuminated signs, advertising media, or the like." W. T. Bell. Dated March 28th.

7,470. "Improvements in apparatus for effecting electrolysis." W. L. Wise. (Solway & Co., Belgium.) Dated March 28th.

7,471. "Improvements in electrolysis." W. L. Wise. (Solway and Co., Belgium.) Dated March 28th.

7,487. "Improvements in electric batteries." R. M. Minton-Senhouse and G. F. Emery. Dated March 29th.

7,514. "Improvements in plates for battery and other purposes, and method of making same." A. Warburton. Dated March 29th.

7,545. "Apparatus for electrically winding springs or weights for clock movements." G. K. B. Elphinstone. Dated March 29th.

7,566. "Improvements in systems of electrical distribution." W. L. Bliss. Dated March 29th. (*Complete.*)

7,569. "Improvements in electric furnaces." H. H. Lake. ("Volta," Societe Anonyme Suisse de l'Industrie Electro-Chimique, Switzerland.) Dated March 29th.

7,570. "Improvements in, and relating to, means for connecting electric cables." F. Clouth. Dated March 29th.

7,575. "Improvements in furnaces for manufacturing calcium carbide, &c." W. P. Thompson. (C. L. Wilson, C. Muma, J. W. Unger, H. Schneckloth, A. P. Brosius, and J. C. Kuchel, United States.) Dated March 29th. (*Complete.*)

7,577. "Improvements in electrical batteries." N. B. Stubblefield. Dated March 29th.

7,583. "Improvements in and connected with electrical switches." H. C. E. Jacoby and White, Jacoby & Co., Limited. Dated March 29th.

7,586. "Improvements in magnetic separators." A. M. Clark. (The Metallurgische Gesellschaft A. G., Germany.) Dated March 29th.

7,700. "Improvements in and relating to shields for incandescent electric lamps and the like." J. Dewar. Dated March 31st.

7,725. "Improvements in holders for incandescent electric lamps." J. M. Huisman and H. C. Gover. Dated March 31st.

7,731. "An automatic electric fog and general signal apparatus." C. Cropp. Dated March 31st.

7,754. "Improvements in and connected with electric motors for motor vehicles, launches, and for other driving purposes and in gearing to be used therewith." J. T. Robson, C. H. Marsden, and H. W. Headland. Dated March 31st.

7,764. "An improved apparatus for the electro-deposition of metals." J. H. Hope. Dated March 31st.

7,825. "Improvements in interchangeable electric signs and the like." C. Raleigh. Dated April 1st.

7,855. "Improvements in transmitting electric impulses and signals and apparatus therefor." E. Wilson, H. Godsal, and C. J. Evans. Dated April 1st.

7,862. "New or improved combined globes and shades for incandescent electric lamps and for electric arc lamps and for facilitating the application of advertisements thereto." E. Bohm. Dated April 1st.

7,873. "Improvements in telephones, electric bell pushes, and the like." A. Anders and Veritys, Limited. Dated April 2nd.

7,895. "An improved construction of fusible cut-out for electric circuits." T. Barton. Dated April 2nd.

7,903. "Improvements in electric interrupters." J. M. D. Soule. Dated April 2nd. (*Complete.*)

7,907. "An improved electrical cut-out." L. Greig. Dated April 2nd.

7,929. "High insulation electric light switch." T. L. Jones. Dated April 2nd.

7,940. "An improvement in coin-freed electric meters." T. H. Minshall. Dated April 2nd.

7,941. "An improvement in holders for electrical glow lamps." P. F. W. Simon. Dated April 2nd.

7,958. "An improved system of electric propulsion for ships, yachts, submarine torpedoes and other purposes." J. H. Barry. Dated April 2nd.

7,961. "Improvements in electric switches." A. Wilson. Dated April 2nd.

ELECTRICAL PATENTS OF 1884, EXPIRING IN APRIL, 1898.

We are informed by Messrs. W. P. Thompson & Co., that about 90 applications for electrical patents were filed in the month of April, 1884. Out of these only four have been maintained to run their full length of term, viz., 14 years, and being of considerable interest we give short abstracts of them below:—

6,288. "Improvements in the adjustments of the mariners' compass." S. M. Moore. Dated April 12th, 1884. Relates to magnetic compasses. The correctors for controlling the errors of the compass are attached to the bowl itself, instead of to any fixed part of the case, thus securing an invariable position and action of the correctors to the compass needle. The magnets for the cardinal errors are placed in a chamber fixed below and forming part of the bowl. They consist of brass rods with a core of magnetised iron of various thickness and are made of uniform size to allow of their being readily interchanged. They are clamped in brackets working in slides of the sides of the chamber, and can be adjusted to any position and fixed by set screws. The quadrantal correctors consist of two balls of soft iron placed in a line with the magnets of the card and adjustable to and fro by screws. They may be fitted either inside or outside the bowl with fluid compasses; they are enclosed in brass cylinders if in bowl. The final adjustment to make the card horizontal is effected by the eccentric weight. 3 claims.

6,414. "Improvements in apparatus for the extraction of metals from their haloid compounds by means of electrolysis." L. A. Groth. (R. Gratzel, Germany.) Dated April 16th, 1884. The haloid salt of a metal such as magnesium or aluminium is melted in a vessel. The positive and the negative electrodes, the latter, and sometimes the former, are surrounded by a cylinder of non-conducting material. The negative electrode may or may not project through the open bottom. The vessel is closed and a pipe is provided for the escape of the haloid gas. "Regenerative" pieces, consisting of an oxide of the metal and carbon may be placed around the positive electrode. Several pairs of electrodes may be placed in the one melting pot.

6,734. "Improvements in electric generators and in working them by fluid pressure." Hon. C. A. Parsons. Dated April 23rd, 1884. Relates to dynamo-electric machines which are specially constructed to be driven by the high-speed turbines described in specification No. 6,735, A.D. 1884. The turbine and dynamo have a common axis, and are mounted on the same bed-plate having a bearing between them. The bearings are specially constructed to permit a slight lateral play, as described in the above-mentioned specification. Lubrication and cooling are effected by the circulation of oil supplied by a pump, which is forced through the hollow shaft. The armature is of the drum type, and the core consists of a number of insulated iron discs arranged on the hollow shaft. At the ends are insulating washers, followed by brass washers forced up by a nut. The iron discs are pierced with channels for the reception of the conductors, or the conductors may be bound with pianoforte wire. The commutator consists of several rings of gun-metal segments held by locking steel rings.

6,770. "Improved means for measuring electric currents." H. Aron. Dated April 24th, 1884. Relates to apparatus for use as a coulomb meter or wattmeter, in which the current is caused to regulate the rate of a clock by acting upon the pendulum or balance-wheel, a magnet or coil attached thereto being acted upon by a stationary coil or coils, or magnet, in such a way as to vary the rate of the clock, and the effect being sometimes increased by iron cores or pieces. In the case of a clock with a balance-wheel, the spring itself may be magnetised. The measurements are made by comparing a clock, influenced by the current, with a normal clock, or by using two clocks, one or both of which may be acted upon by the current, which impart their motion to a differential counter. Various modifications are described.